MAY 16 1912

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second class matter May 7, 1906, at the Post Office at San Francisco Cal., under the act of Congress March 3 1879

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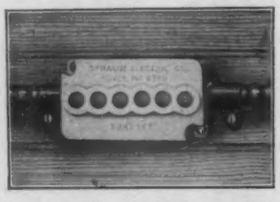
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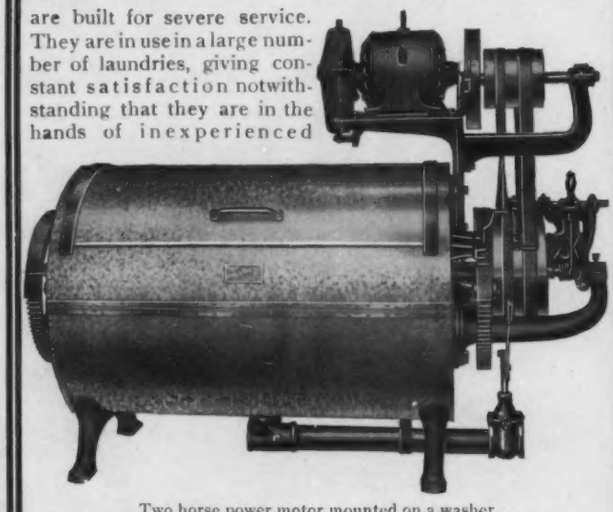
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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXVIII SAN FRANCISCO, MAY 11, 1912 NUMBER 19

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William G. Kerckhoff, President.

Allan C. Balch, Vice-President.

A. G. Wishon, General Manager.

SAN JOAQUIN LIGHT & POWER CORPORATION

By Rudolph W. Van Norden
Member A. I. E. E., A. S. C. E.

The San Joaquin Light & Power Corporation of today is a natural evolution of one of the first long distance transmission systems to be built; in fact the first system to transmit electricity for power a distance of 36 miles.

The use of water from the streams of the Sierra Nevada under high head for the supply of power to operate gold mines is but part of the history of California, but the transmission of this power for use in the cities of the valleys, remained eighteen years ago as a great problem to be solved by the electrical engineer, backed by the indomitable will and courage of those who were destined to become the pioneers of a tremendous commercial awakening.

In 1896 the old "San Joaquin" plant was placed in operation. Comment of every degree was offered, not only on the boldness of such a transmission but on the daring of the development itself, due to the great head under which the pipe line and water wheels operated. This pioneer plant was operated for a period of fifteen years, while the system in passing through many stages of increased size and usefulness finally demanded its replacement by something more modern and efficient. In 1911, upon the completion of a greater power house, the old San Joaquin No. 1 passed into history.

Originally the system consisted of a transmission for the commercial light and power supply in the city of Fresno. In 1900 this was extended to Hanford, where power was sold to a local company. In 1902 the company, through a sequence of adverse local conditions, became financially embarrassed and was sold to a new company, composed of men, themselves pioneers in the field of electric transmission.

These men, Wm. G. Kerckhoff and A. C. Balch, assumed control December 1, 1902, and A. G. Wishon was made general manager in May, 1903. The first two were connected with the Pacific Light & Power Corporation, as president and general manager, the latter being one of the originators and a part owner of the Mt. Whitney Power Company.

Mr. Kerckhoff's interest in electric power was a natural sequence of good business training and foresight as to the future possibilities of the southern districts of California. In 1879 he became interested in lumber and organized a company which built a mill, this industry playing an important part in the development of Los Angeles. In the course of time a chain of docks was established and a great shipping business developed. In 1898, together with A. C. Balch, Mr. Kerckhoff organized the San Gabriel Electric Company. This was destined to become the nucleus of the great Pacific Light & Power Corporation, of which Mr. Kerckhoff is now president and Mr. Balch vice-president and general manager.

In 1902 the opportunity of acquiring the San Joaquin property, then bankrupt, and the perception of its immense possibilities prompted the formation by these men of the San Joaquin Light & Power Corporation.

Mr. Balch as an engineer realized the feasibility of the plan which has now been established, and the story of this company, together with the subsequent development, until now a territory of 20,000 square miles is served, is one of exciting interest. A. C. Balch is closely associated with the early development of power transmission. Upon graduating from Cornell University in 1889 with the degrees of M.E and E.E., he went to Seattle, Wash., there becoming a member of the engineering firm of Baker, Balch & Co., but later became manager of the Home Electric Company. This was consolidated with several other companies, to form the Union Electrical Company, of which he also was manager for a period of two years. In 1891 he became manager of the Union Power Company at Portland, Oregon, and here built a steam plant near the mill of the Northern Pacific Lumber Company, which for a time supplied all of the power to the local railway system. In 1896 he became associated with Wm. G. Kerckhoff in Los Angeles and in this year built the Azusa plant now a part of the Pacific Light & Power Corporation. In 1902 with Mr. Kerckhoff he financed the purchase of the San Jacinto Company. This deal was the culmination of a sequence of events caused by the pioneer struggle to develop and transmit power for pumping and thus developing a hitherto barren district. Mr. Balch has now many other large electric, gas and water interests.

As a real estate dealer in Visalia, Mr. Wishon foresaw the enormous possibilities to be derived from irrigating land suitable to orange growing about Exeter and Lindsay and set about to devise means to do so. Much of this land, now almost priceless, was bought for $15.00 per acre and much sold at a substantial profit. A plan to build a canal to carry water from the Kaweah River cost all he had and more, and, though unsuccessful, only served as a spur to determination.

After innumerable disappointments and many delays, Mr. Wishon made a sale of real estate netting $4000 and with this Wm. Hammond journeyed to England with the hope of financing the new project, through an introduction to a powerful syndicate by his brother. An elaborate prospectus had been prepared as there were then 25 steam-driven pumping plants for the irrigation of orange groves. The result of this trip abroad was to interest his brother, John Hays Hammond, in the project, and he agreed to furnish the necessary capital, offering Mr. Wishon and Wm. Hammond a fifth interest. This offer was accepted and a promise was made that within one month the money would be ready.

So eager was Mr. Wishon that he immediately visited all existing plants to learn if possible the manner in which the new problem of power transmission was being handled. With a good understanding of the primary principles but without financial aid or advice, he went into the mountains and rented mules from the Sanger Lumber Company, bought timber and hauled 1,000,000 feet of sawn redwood timber to the power site, to be used in the construction of a flume. Working in a frenzy of eagerness, sleeping under wagons and spending $15,000 of money furnished by himself, he completed six miles of flume. Meanwhile the power plant was constructed with all abiding faith of an eagerly waiting market.

But steam pumps were doing the work successfully,—arguments, cajolery, all, were of no avail. A mass meeting of farmers was held to hear reasons for the adoption of the new power, but without results. it looked as if the builders of the plant really were dreamers, and that they had only a white elephant as a tragic ending of their hopes. There was some lighting business, it is true, and the steam plant in Visalia with its business had been purchased, but it did not begin to pay expenses.

Then there was an idea—a big idea. A few farmers were approached and told that the company would install the motor and equipment for pumping without charge, if satisfied the farmer could pay for the outfit in six annual installments and 6 per cent interest, that the company would connect to existing pumps and if not satisfactory there would be no obligation. He had already told his plan to a Visalia banker and asked for a loan of $25,000 to buy pumps and equipment. Again he was laughed at. But a dozen farmers agreed to the plan and armed with the signed agreements he made application for the loan from a San Francisco banker with whom he was successful. The starting of the first pump was a great event, but it was a sad day for the jeerers.

Within a year all twenty-five plants for which the loan provided had been installed and the company was more than paying expenses. The next year was one of rapid growth. Thus it was that A. G. Wishon emerged from a purely commercial pursuit, one of the pioneers of electric transmission development. In 1903 Mr. Wishon took the management of the newly formed San Joaquin Light & Power Corporation and together with and under the direction of Mr. Kerckhoff and Mr. Balch was destined to transform much of the San Joaquin Valley, a vast semi-arid waste, into a gigantic garden for the support of millions of souls.

Description of Territory.

Intake Tower at Crane Valley.

SOME 20,000 square miles embraced in the great San Joaquin Valley, the southern half of the great central valley of California, are served by this company. This territory extends from Merced on the north in a southeasterly direction for 200 miles and from the Sierra Nevada mountains on the east to the Coast Range on the west, a distance of 75 miles. Included in its scope are the counties of Merced, Mariposa, Madera, Fresno, Tulare, Kings, Kern, San Luis Obispo, Santa Barbara and Monterey, equal to the combined areas of the States of New Hampshire, Massachusetts and Connecticut. Throughout this expanse there is not a section that is not or cannot be reached by electric wires.

There are a number of flourishing cities, two of them, Fresno of 40,000 and Bakersfield, of 20,000 population. But this, except as evidence of prosperity, is not an indication of the resources of this region, for it is the rural and mineral districts that give greatest promise in the cultivation of the fertile soil or the freeing from nature's treasure house, its wealth of liquid fuel.

The power system is operated in two main divisions. The northern with its nucleus at Fresno, covers a great and fertile agricultural district, and, reaching high into the Sierra Nevada mountains, embraces the two principal hydroelectric power plants on the San Joaquin River which ordinarily supply a large part of the current for the entire network. The southern division includes the Kern and Midway oil fields, the city of Bakersfield, where the office and directing head of this division are situated, and a great sweep of country, at present largely undeveloped, but whose potentialities can only be appreciated by viewing what has already been done by the application of water and then imagining the hundreds of sections and even

Kearney Drive, Fresno.

townships which stand ready to produce as bountifully at the will of man.

The district about Fresno has long been known for its marvelous fertility, and illustrates what can be done by irrigation from the rivers. The city is one of wide shaded streets, handsomely built business blocks with many imposing public buildings of steel and stone, strong banking houses and large mercantile enterprises of varied character; in short presenting every evidence of unusual and well distributed wealth. For miles around, but particularly to the east of the city, are thousands of acres of vineyards which supply the great wineries and raisin driers for whose products this district is world-famed. To the north is the large park which was given to the city some six years ago, under the provision that $200,000 be spent in its improvement. This has resulted in an arboreatum which any city many times the size of Fresno might justly envy. The sight which visitors are shown with greatest pride is the Kearny Drive, a magnificent avenue leading seven miles from the city, to a great country estate and lined on

Fresno Court House.

both sides with giant palmettos behind which stand stately eucalyptus trees.

To the north, after crossing the San Joaquin River into Madera County, is a country equally susceptible of cultivation, but less developed because of the lack of irrigation possibilities. Here then, is where the opportunity for motor pumping becomes more evident. For water is almost at the surface and many a conservative farmer, who required a lot of "showing," is now irrigating his six crops of alfalfa and reliable fancy fruit trees, where, not so long ago he raised a crop of wheat,—if it happened to be a "good year"—and he has become the best boosting advertisement for the sale of power that can be obtained. These conditions embrace the district to the northernmost limit at Merced and extend across the valley so as to take in the west side towns of Los Banos, Dos Palos, and Mendota. Between these towns and the Coast Range is an immense area of gently sloping land capable of the highest cultivation. Water on the west side, however, is not so easily obtained as in the center of the valley or the east side. A pumping project, which will require 14,000 h.p. in large units and which will draw water from the river bottom lands is now being undertaken to distribute it over this section.

South from Fresno, through Fowler, Selma, Kingsburg and then easterly through Dinuba, Exeter,

Creamery at Fresno.

Creamery Interior.

Visalia and Lindsey to Porterville, a veritable garden of Eden is disclosed—all through the touch of Nature's magic wand—water. In many of these sections the electric distributing lines become a network following crossroads and lanes, for the well-to-do farmer,—and they are all of this class,—must have electricity, not alone to drive the pumps, but for a generous domestic use.

Nearing the foothills and extending well up on their slopes are the orange orchards, not in isolated patches, but in solid ranks, mile after mile as far as the eye can reach. It is here that the possibilities of irrigation are most vividly illustrated. For there are many problems, each differing in the manner and method of handling the water but all dependent upon the ever-ready motor. The future possibility of this country is nowhere better shown than here; for this orange producing soil extends in a solid unbroken strip, five to ten miles wide and one hundred and fifty miles long following the Sierra Nevada foothills, past and beyond Bakersfield to the end of the valley, where meet the two mountain ranges which bound it.

The great valley itself, in a strip fifty miles wide, is equally ready for cultivation, and, with the exception of the west side, water is at or near the surface.

Vineyard East of Fresno.

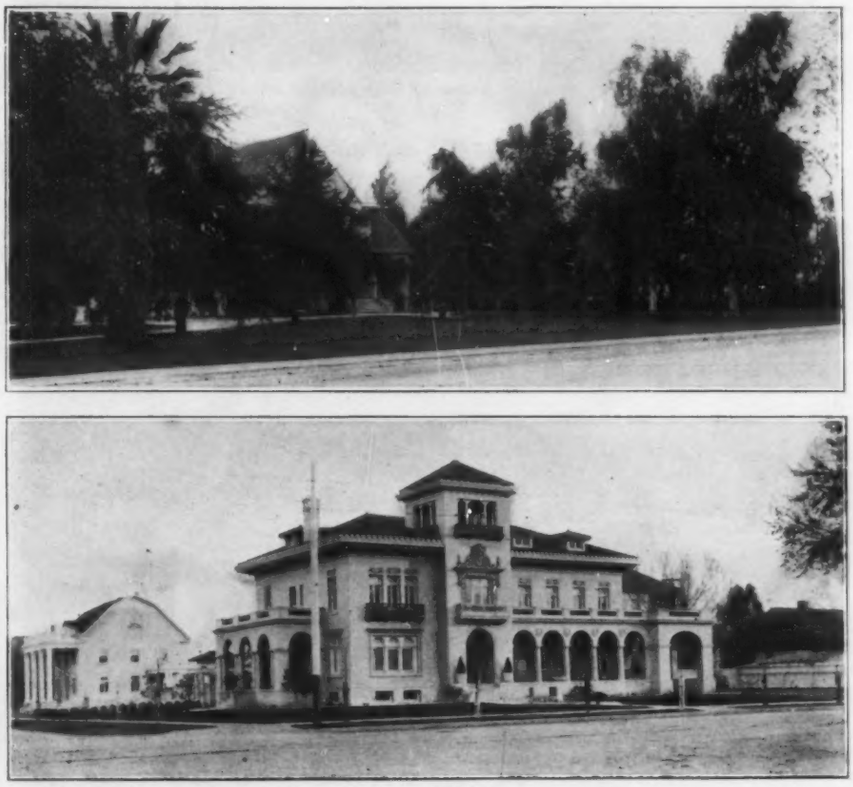
This vast area is suitable for the cultivation of alfalfa and fruit, particularly the former as it is a crop easily cultivated and always profitable. Below Lake Tulare there are already several colonies of settlers who within the space of three or four years have reclaimed land which heretofore had been considered but a desert waste. At their limits may be seen vivid examples of this cultivation, on the one side a knee-deep field of alfalfa, verdant and luxuriant, on the other a sparse growth of sage on an otherwise bare plain. In one district below Bakersfield, through which the lines are now built, there is said to be as much land available for fancy orange culture as is at present planted to orange groves throughout the State of California.

The northern and southern division networks are connected through a main transmission line, following the general southeasterly direction of the valley, passing to the west of Lake Tulare, through the McKittrick, Midway and Maricopa oil fields, and thence to Bakersfield. The branch lines of the northern division on the east side and similar circuits running north from the southern division practically meet, but there is now under construction a second main transmission line from north to south which will pass down the east side.

The other branch of the available power market is the supply for operating the pumps, derricks and drills in the oil fields; a business that, ten years ago the lay mind would have thought an idle dream, but now becoming more and more a stern reality, taxing the resources of the company in every direction to supply. The probability of a thirty horsepower installation at each of four thousand existing and operating oil wells furnishes food for much reflection.

Bakersfield is a city which has received its impetus in growth since the discovery of fuel oil. Like Fresno, it is well planned, with a substantial commercial section and strong business enterprises. The surrounding territory, not being in the state of complete cultivation which is true of Fresno, does not afford such great wealth to the city from agricultural pursuits. But the potential values are everywhere evident and the suburban development is as well assured as are the products of the soil when electric current is the medium of raising the underground water. A great sum of money has been invested by the power company in anticipation of the future development of this district and the wisdom of so doing becomes more and more evident as time unfolds.

The southern division boasts of one hydroelectric plant at the mouth of the canyon of the Kern River. This is the smallest of the hydraulic plants but it has done faithful duty since the early days of long distance transmission.



Fresno Homes.

In Bakersfield is the steam auxiliary plant, the standby for the system. This new installation is modern and complete and offers an unfailing source of power in the event of failure of the transmitted power.

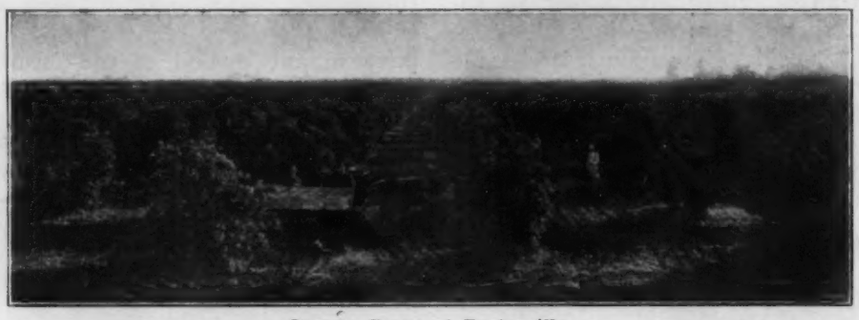
The company will eventually build two additional hydroelectric plants on the San Joaquin River. It also owns water rights on the Tule River, and a new plant is under construction. These, together with existing installations, will aggregate 100,000 h.p.

Outside of this territory the company furnishes power at wholesale to other companies, all of which except the Tulare Power Company are owned and controlled by interests coinciding with those of this company. These include Coalinga and the surrounding oil district, Paso Robles, Santa Maria, San Luis Obispo, Arroyo Grande, San Miguel

Stone Canyon and Santa Margarita, and add to the directly operated territory about 7000 square miles.

Business of the Company.

Covering such a vast region as does this system it is natural to expect that many different forms of power consuming enterprises will present a varied market for the sale of power. To the outsider, unacquainted with the wonderful possibilities of the territory covered, it may seem strange at first thought that a scattered score of small cities could offer a market for twenty-five thousand horsepower with an assured future prospect of several times this amount. Let the observer, however, see a few of the irrigating pumping plants surrounded by the magic results of their operation, or, visit the oil-fields with their countless derricks, each one of which, if not already supplied with electric current, is a probable future customer, the wisdom and foresight shown in the conception of this system and the enormous market possibility cannot but be forcibly impressed upon the most conservative mind. For it is from these two great industries that the system can draw its business. Of course there are many other industries forming a part of the market, of a more conventional nature, either in existence or in project, railroads, rock-crushers, mills, factories and immense ice-making plants, to say nothing of lighting and domestic service. But the steady pumping loads of thousands of motors ranging from 20 to 150 h.p., form the backbone of the load and make a business which, fifteen years ago was scarcely conceived.



Orange Grove at Porterville.

Pumping for Water Supply.

A description of the lands suitable for irrigation from wells has been given, but a description of the methods in various localities may be interesting. One of the most striking illustrations of the efficiency of electric pumping may be had in the intensely cultivated districts on the immediate north, south and east of Fresno. This district has perhaps the most complete and comprehensive system of irrigation canals in the state, into which water is diverted from the Kings River. Even with this system, there are lands which are not reached by these canals and it is here that pumping from wells with electric motors has shown highly favorable results in comparison with the cost from canals and with the added advantage of

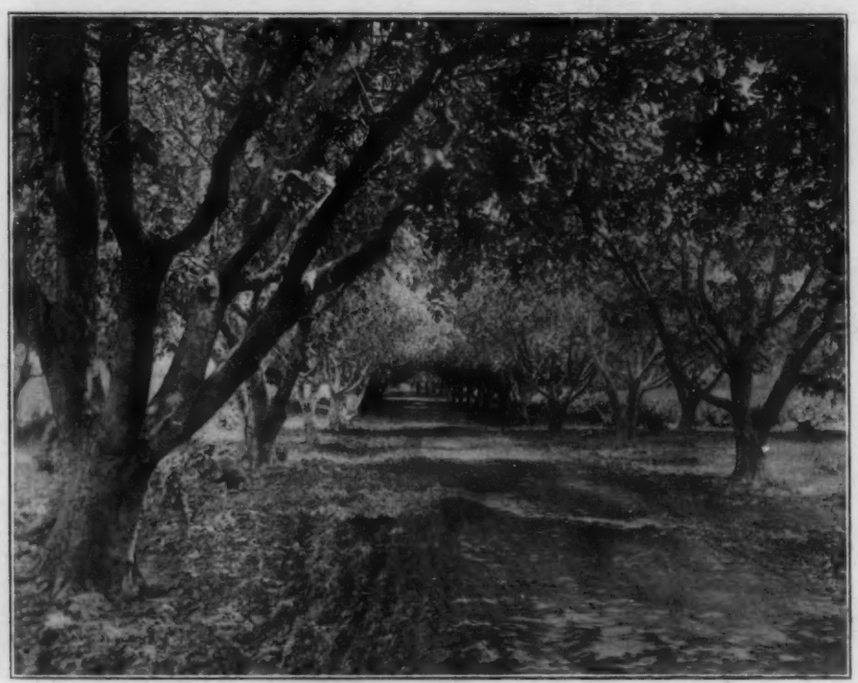


Fig Orchard and Vineyard at Fresno.

having water free from weed bearing seeds which are likely to be distributed from the canals.

Throughout the San Joaquin Valley, except on the western slope, the sub-surface flow is never at a great depth. In the upper section of the territory, extending from the foothills, to and beyond the center of the valley, an unfailing supply of water is found at a depth of 15 to 30 ft. From the San Joaquin River,

Motor Drive in Santa Fe Crusher.

south to Lake Tulare, the water is often within two or three feet of the surface, and in the district about Corcoran, there are a number of flowing artesian wells.

There is seldom any question as to the fertility of the soil except, perhaps, in a few restricted sections in the center and therefore the lowest points of the valley where alkaline deposits have come to the surface, and these lands may be alternately flooded and drained to leach out the minerals. There is therefore full assurance of abundant crops, having invariably suitable soil and an ample supply of pure water.

Typical Farm Pumping Plants from Wells and River.

In the northern and eastern sections of the territory may be found the conventional pumping plants, every ready for their duty of irrigation. The arrangement and size depends on the surface grade and the area to be irrigated. In many cases two or more wells supply water for a single pump; in many cases but one well is sufficient. These plants are quite similar and comprise two types. One is the direct connected motor-pump, in which the motor and single stage centrifugal pump are mounted together on a common cast iron base, the unit being placed at the bottom of a pit at practically the standing surface of water. The other form is, as a rule, more or less temporary in character and consists of a centrifugal pump with vertical shaft, placed in a sump at the water level,

Finn Colony Pumping Plant.

the driving motor being belted to a pulley on the pump shaft.

A typical farm equipment of the first named class consists of a concrete lined pit, 8 x 12 ft., with 8 in. walls, in which are imbedded steel I beams with L braces for stiffness. The floor of the pit is 27 ft. below the ground surface. There are two wells 4 ft. apart opening into this pit and between them is placed the pumping unit which consists of a Westinghouse 20 h.p. 3-phase induction motor, direct connected to a No. 6 centrifugal pump. Over the pit is erected a neat wooden house which contains the controller, switch and meter. The pole structure nearby carries three 7½ kw. 6600/440 volt transformers, these are star connected on the primary side to the 10,000 volt lines. In providing service of this order, the

Vineyard Pumping Plant.

company assembles and arranges the outfit in accordance with the standards adopted for the system and makes the installation for the customer. The latter pays outright for the pumping unit, the transformers and the section of transmission line which it may be necessary to build from one of the distributing lines. In building a line into a certain locality, the

locations of the wells of prospective customers are determined as nearly as is possible, and the line is located so that the least possible burden of cost will fall on the customer for his line.

In the plant described above, 1025 gal. per minute are delivered against a head of 42 ft., the vacuum being 14 ft. This requires 18.8 h.p. measured at the motor, which shows an efficiency for the pump of somewhat over 60 per cent.

The cost to the company of installing a rig of this sort, including the hanging of the transformers and making all connections is about $75.

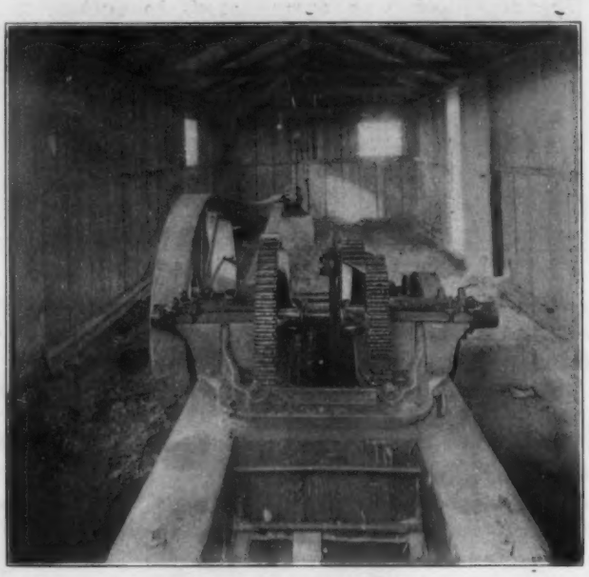
Following is a list of material and costs of a standard pumping equipment:

Labor and Material for Equipment for Installing Electrical Motors and Transformers.

	Size	Amount	Cost	Size	Amount	Cost
Motor, 220 volt*	3 h.p.	1	64.85	30 h.p.	1	513.80
Transformers, 6600 volts	2 kw.	3	177.90	10 kw.	3	393.00
Pole	35′	1	8.00	35′	1	8.00
Crossarms	Style D	2	1.60	Style D	2	1.60
Crossarms	Style G	2	1.60	Style G	2	1.60
Lag screws and washers	½x3½	6	.09	½x3½	6	.09
⅝″x16″ bolts and washers.	⅝x16	4	.30	⅝x16	4	.30
⅝″x14″ bolts and washers.	⅝x14	2	.14	⅝x14	2	.14
⅝″x12″ bolts and washers.	⅝x12	2	.14	⅝x12	2	.14
Sets 6600 volt line fuses complete (warning signs)	Set	3	18.00	Set	3	18.00
1′ blocks	1′	3	.30	1′	3	.30
Type A conduits	¾″	2	.54	2″	2	1.90
Type B conduits	¾″	1	.40	2″	1	1.28
Type F conduits	¾″	1	.60	2″	1	3.00
Conduit ells	¾″	6	.66	2″	6	3.00
Conduit straps	¾″	12	.06	2″	12	.12
Conduit ground clamp	¾″	2	.28	2″	2	.28
Conduit	¾″	80′	5.12	2″	80′	16.00
Angle iron frame and board.	2′	1	4.00	2′x6″	1	5.00
⅛″ sheet asbestos	⅛″	2′x4′	.35	⅛	3′x4′	.41
3 P. S. T. switch, 250 v., and screws				150 A	1	4.50
3 P. D. T. switch, 250 v., and screws	25 A	1	1.15			
Fuse block, 3 p., 250 v., and screws	25 A	2	.80	150 A	1	3.50
Cartridge fuses, 250 v. (running)	10 A	3	.45	95 A	3	1.29
Cartridge fuses, 250 v. (starting)	20 A	3	.66	150 A	3	1.29
R. C., D. B. flexible cable.				No. 1-0	300′	39.00
Primary fuse wire	½ A	12′	.05	3 A	12′	.10
R. C., D. B. wire	No. 10	300′	4.14			
W. P. wire	No. 8	50′	.76	No. 6	50	1.14
S. D. bare wire	No. 6	100′	1.40	No. 6	100′	1.40
H. D. bare wire	No. 8	400′	3.50	No. 8	400	3.50
10,000 volt insulators		12	1.56		12	1.56
2,000 volt insulators		12	.48		12	.48
Standard iron pins	8″	16	3.20	8″	16	3.20
Locust pins		8	.16		8	.16
Black pipe	⅜	18′	.45	⅜	18′	.45
Guy boxes		1	.75		1	.75
Pole steps		21	1.05		21	1.05
Lbs. solder		1	.30		2	.60
Gal. gasoline		½	.15		1	.25
Loom	⅜″	20′	.80	½″	20′	1.00
Porcelain tubes	5-16x3″	18	.12	5-16x3″	18	.12
Porcelain tubes				¾x3	12	.24
Lbs. solder paste		⅛	.08		¼	.16
Rolls friction tape		3	.39		3	.39
Rolls rubber tape		2	.50		2	.50
Conduit box and nails (to fit conduit)		30′	2.85		30′	3.75
Total cost of material.			310.68			1037.11
Overload and low voltage coils					1 set	
Team						
Labor			20.00			36.00
Hotel expense						
R. R. fare & traveling time.						
Total cost						

*NOTE.—Prices on motors include sliding base and pulley and on motors over 5 h.p., compensators. Low voltage and overload coils extra. Prices are approximate f.o.b. Bakersfield and are subject to change.

In the district adjoining the hills south of Bakersfield, deep well conditions are met. The land is unusually fertile and with water is particularly suitable for orange culture. The deep well pumps are of the plunger type, the pump cylinders being placed in the well below the water surface. The plunger is operated with a vertical motion by a bell-crank or walking-beam, which in turn is moved in its reciprocating motion from a crank mounted at the end of a counter shaft. To this counter-shaft is belted the driving motor. The whole is enclosed in a suitable wooden house. One of these pumps near Edison operates

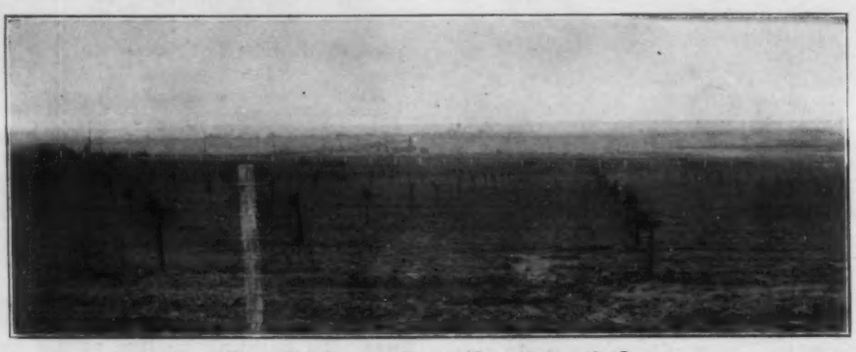


Motor Drive for Mine.

a well 175 ft. deep; the motor is a Westinghouse, type CCL, 40 h.p. The pump delivers 61 miners' inches (statute) of water equivalent to a flow of 1.22 cu. ft. per second. This will irrigate 320 acres of land at the plant level. The power bill amounts to $5.00 per acre per year, allowing one miners' inch to the acre and four irrigation per year. Still other pumps raise water from streams discharging into irrigation canals.

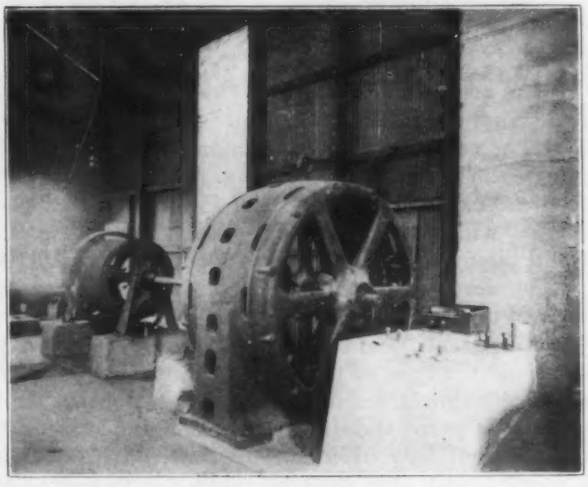
While there are hundreds of these plants installed throughout the territory, with many times the number to be installed as the population increases and the great expanses of uncultivated lands are developed, there are in project irrigation developments on a wholesale scale which will require large blocks of power.

On the west of Lake Tulare, is an enormous dis-



Year-Old Orange Grove Near Bakersfield.

trict of 175,000 acres. It is apparently arid and desert land and of little value without water. There is no substratum of water near enough the surface for economical pumping. Plans have been perfected to pump water from Lake Tulare into a system of irrigating canals, leaving at all times an area of water in the lake of 25,000 acres as a reservoir. This supply is



Deep Well Pumping Installation.

to be supplemented by wells on the east side of Kings River. This will supply abundant moisture for the entire 175,000 acres, will be highly feasible and economical and will require 14,000 h.p. to raise and distribute the flow.

There are already throughout the valley a number of colonies which pump water in large quantities and distribute it throughout the holdings. At the Alpaugh Colony pumps, about 30 miles northwest of Bakersfield, there are seven wells. Each of these wells is equipped with a unit comprising a 20 h.p. induction motor driving a 7 to 8 in. centrifugal pump. Each pump delivers 1500 gal. per min. into a common canal. This carries the water eleven miles to the Alpaugh colony where it is raised 7 feet by a 50 h.p. motor-pump into distributing canals and thereby does duty in irrigating 8000 acres of what is now most productive land. The cost of this irrigation to the colonists is $1.25 per acre per year.

Another vast project is the irrigation of a section containing 250,000 acres west of Mendota, on the west side of the valley. It is proposed to install two pumping plants with units of 500 h.p. to pump from and drain the land adjacent to Kerman, the water being raised by a myriad of 15 h.p. well plants, raising the water to a level sufficient for distribution over the area. This will require altogether about 8000 horsepower.

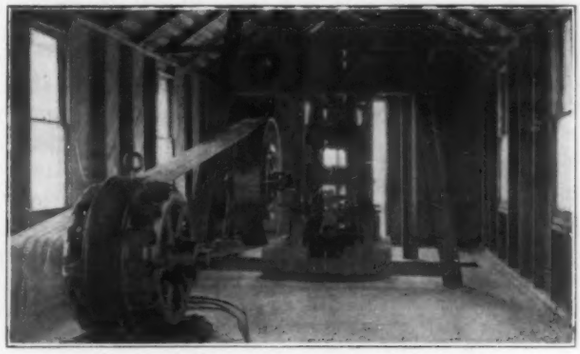
A very interesting use of water from a small pumping plant is illustrated in an orange ranch near Porterville, on which the Skinner system of overhead irrigation is used. In this system galvanized wrought iron pipe is carried through the tops of the orange trees, a line of pipe for every other row of trees; it is supported 8 ft. above ground on 4 x 4 in. redwood poles. Suitable valves are provided so that water may be supplied to any row of pipe at will and the joints are so arranged that the line of pipe may be turned to throw the spray in any direction desired with reference to wind and sun. Holes for the nozzles are drilled in the pipe every four feet and ¼ in. brass nozzle bushings are screwed into these holes. These nozzles are drilled in three sizes, depending upon the amount of irrigation desired, the smallest hole being not much larger than a horsehair.

In the ranch in question the equipment on one 10-acre sidehill tract is 180 ft. of 1½ in. galvanized pipe, 180 ft. 1¼ in., 170 ft. 1 in. and 100 ft. of ¾ in. The lift of the sidehill is 32 ft. The well supplying water for this installation developes 10 miners' in. of water. It is found that it is possible to irrigate 30 acres at a time. The system cost $150 per acre to install outside of the cost of pump and well plant.

The pumping plant is a 40 h.p. induction motor direct connected to a centrifugal pump placed at the bottom of a stave line pit 22 ft. below the ground surface. The actual power required to deliver 100 in. of water is 34.92 h.p.

The power bill for irrigating 155 acres as at present installed is $144 per month. This figure can probably be lessened as the equipment is increased and the plant becomes more systematized. This method of irrigation has a number of advantages. The water is delivered at a temperature of 65 degrees. This is a good frost preventative as the trees may be kept at near this temperature on cold winter nights. It is necessary to cultivate the ground but once a year and that when fertilizing. Clover may be planted between the orange trees successfully and this is being done.

When this system was first installed the fruit output was two boxes per tree per year. At the present time the crop is three and one-half boxes of fancy fruit. An increase of two boxes per tree pays for the plant the first year. The owner states that it is his full belief within the next three or four years by the use of this system the crop will become ten boxes per tree.



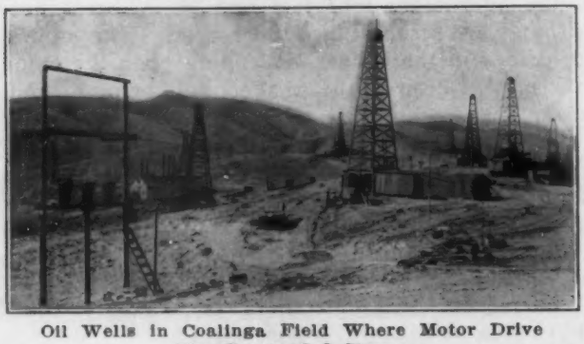
Typical Motor-Driven Deep Well Pump.

Oil Pumping.

The possibility of operating oil wells and derricks with electric motors in place of the steam engines used in common practice opened an enormous opportunity for the disposal of electric current.

The five oil fields in the San Joaquin Valley have about 4000 oil wells. This number is constantly increasing and while wells gradually become pumped out others are brought in in greater numbers.

The conventional operation of oil wells is so well standardized that any new method or system which might be a radical improvement in operating methods



Oil Wells in Coalinga Field Where Motor Drive Has Superseded Steam.

has been extremely difficult of introduction, and the conservatism of operators has been an almost insurmountable obstacle for the electric company to overcome, notwithstanding every advantage in favor of electric operation.

There are a number of glaring disadvantages in the use of steam engines. Principally among these are the low efficiency of the engine, the extreme losses in the transmission of steam, which are aggravated during cold weather, the higher cost of attendance, the almost prohibitive cost of water, and a very great depreciation, especially in the boilers.

All of these features are obviated in the use of motor drives. The costly boiler plant and water distributing system is eliminated, the efficiency of machinery is at the highest point and there are no transmission losses. During cold weather, when there is danger of uncertain operation by the engine due to condensation in the steam pipes, there is a liability of buckling the pump rods, and where there is a sudden increase in the steam pressure there is the danger of breaking the rods. These dangers are greatly lessened with electric drive as temperature conditions have practically no effect upon its operation.

In the Coalinga field a set of boiler tubes seldom last over six months, due to the nature of the water available. Throughout this field it has been shown that the cost of operation, including depreciation and overhead expense, with electric drive will average 40 per cent less than with steam engines. In some isolated cases this has been shown to be as much as 60 or 70 per cent.

The only competitor in point of cost of operation with the electric motor is by the use of a gas engine supplied with natural gas from the wells. The actual cost of operation is about the same. The cost of the installation, however, is somewhat greater. After eight months operation the depreciation costs of the gas engine plant begin to increase and shortly bring the costs of operation to a much higher figure. After an electric plant is installed, there is practically no depreciation.

There are also no standby losses, the expense of running the plant ceasing when it is not operating. The standby losses in the steam plant are very large and form a serious factor in the general cost of operation.

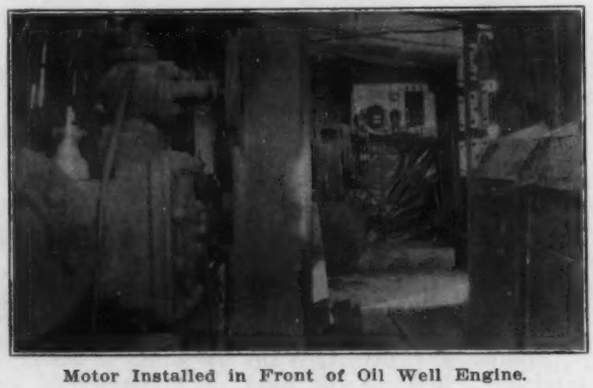
In the Coalinga field the following example of operating cost cover the supply to a group of wells of two-boiler plants having 12 boilers.

1600 lb. boiler compound	$ 72 00
Boiler repairs; taking out tubes, cleaning and welding	165 00
Cost for new flues	64 75
Wages of four boiler men and four helpers	650 00
Cost of 3300 bbls. of oil at 30c	980 00
Total cost of operation by steam	$1931 75
Total cost of electrical operation for above case	$ 715 25

Total cost of electrical operation for above case, $715.25.

It is actually figured in this district that the cost of electricity for pumping a well is $1.00 per well per day. The cost of the motor equipment in comparison tc the steam equipment is startling. A 30/10 h.p. variable speed motor with 3-10 kw. transformers and all connections will amount to about $800. The boiler outfit and piping for a steam plant alone will cost $1200.

The development of the motor drive has been the result of much study on the part of oil well engineers. While different localities require different operating conditions the type of motor and equipment has been fairly well standardized. In pumping, no two wells require the same speed of stroke and the same well may vary not only from time to time, but from hour to hour. Great care must be taken not to overpump and cause the well to "sand up." For this reason a closely graduated variable speed is necessary and it must be possible to control this speed instantly from the derrick. The motor must be capable not only of operating the pump, but also a hoist to be used in drawing the casing and also in drilling and cleaning out. These latter operations require more power than pumping.



Motor Installed in Front of Oil Well Engine.

In order that a single motor may operate efficiently with the various kinds of load, which requires about 6 to 8 h.p. while pumping and as high as a momentary pull of 50 or 60 h.p. when hoisting the bailer, when full, in most cases a two-voltage 30 h.p. variable speed motor is employed. The primary winding on this motor is designed for a delta connection, which enables the motor to develop its full power with a possibility of 100 per cent overload. By throwing a 2-way three-pole switch the stator of the motor is connected to the line in star; thus giving it a high efficiency under small loads. A rheostat and street railway controller throw in and out resistance to the secondary circuit, providing the variable speed feature. This controller is operated through an endless chain with a control wheel on the derrick, thereby

obtaining the fine graduations of control which can be had from a steam engine.

The great difference in speed between the motor shaft and the crank shaft operating the pump beam necessitates an intermediate speed reducing shaft. There are two methods employed to obtain this. One is to introduce a countershaft which necessitates two belts, while the newer and more compact method is a back gear mounted on the motor, thus requiring but one belt between the motor and the crank shaft. The former method however gives the best results due to the flexibility of the belts which allows a cushioning action upon the suddenly applied up-stroke of the pump.

In the Midway and Kern fields where current is supplied directly to the wells by this company, a standard motor equipment assembled at the company's shop in Bakersfield has been adopted. This equipment is efficient and complete and consists of a 440 volt 30/10 h.p. variable speed induction motor equipped with back gear shaft and pulley. The rheostat and controller are mounted together and at the side of the rheostat is a galvanized sheet iron box, with a double hinged door of the same material, the whole lined with asbestos board. Within this box are mounted the main switch, fuses and integrating wattmeter. The incoming wires are brought through steel pipe conduit and the connections between the motor and the control are also in steel pipe conduit. This standard rig costs as follows:

1	1½-in. Type F condulet	$ 1.24	$ 1.24
1	1½-in. Type E condulet	.80	.80
6	1½-in. Type A condulet	.70	4.20
70	ft. 1½-in. conduit	.16	11.20
6	1½-in. conduit couplings	.08	.48
10	1½-in. conduit ells	.45	4.50
6	1½-in. conduit lock nuts	.033	.20
6	1½-in. conduit finishers	.05	.30
200	ft. No. 4 flexible R C wire	.051	10.20
50	ft. No. 4 flexible asbestos covered wire	.06	3.00
1	500 volt 100 amp. S T S P switch	4.50	4.50
3	500 volt 50 amp. S P fuse blocks	1.00	3.00
3	500 volt 80 amp. cartridge fuses	.75	2.25
3	500 volt 30 amp. cartridge fuses	.75	2.25
18	1½-in. pipe straps	.01	.18
1	1 angle iron frame and box complete, lined with ⅛-in. asbestos board	16.00	16.00
6	1½-in. grounding straps	.14	.84
6	rolls friction	.13	.78
2	lb. string solder	.30	.60
½	lb. soldering paste	.64	.08
25	1½-in. x No. 8 wood screws (per gro.)	.16	.03
30	ft. 1½-in. conduit casing	.125	3.75
			$70.38
	Labor		20.00
	Hotel		
	Railroad fare		
	Traveling time		

Many of the wells cannot be operated steadily due to the fact that the oil would be exhausted after a certain period of pumping. These are known as spasmodic wells and are particularly suitable for single motor installation. Where it is possible to operate a group of wells mechanically from one central point a device known as a jack is used. Jack rigs are particularly noticeable in the Kern field and are operated as follows: An induction motor of suitable size, generally about 50 h.p. is belted or geared to a vertical shaft. This shaft extends through the roof of the enclosing building and on its upper extremity are two eccentrics with bands, similar but considerably larger than the eccentrics of a reversible steam engine. Fastened to the bands are steel cables which extend in the various directions of the derricks which are to be operated. The cables terminate in a walking beam or reciprocating bell-crank which operates the plunger rod of the well. The movement of the eccentrics gives a reciprocating motion to all of the cable lines and thus the wells are all pumped from one motor.

With electric drive it will pay to pump a well which will not deliver over six barrels per day, while with steam the cost to operate per day would equal the selling price of ten barrels. There is, of course, a great variation in the amount of oil a well will give, and this in steady flowing wells amounts to as much as 120 barrels per day.

The change from steam to electric driving may be made in a few hours as the transformers can be set and the motor erected often without stopping the engine. The shutdown then only requires the time necessary to change the belting.

Jack-Rig in Kern River Field.

Portable drilling outfits are used by well drillers and can be moved from well to well. This outfit consists of a 30/60 h.p. induction motor with back gear and controller and a special change gear mounted on the same base. With this means drilling can be quickly and efficiently accomplished.

The actual saving in the installation of motor drive in the cost of operation alone will pay for the motor equipment in 18 months.

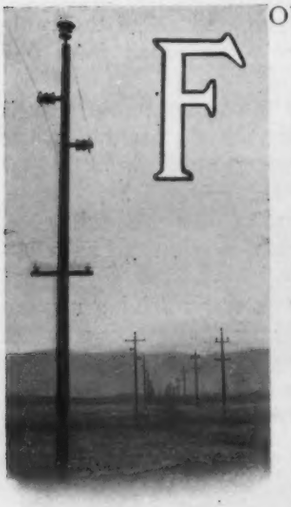
In the Kern River, Maricopa, Midway and McKittrick fields there are now installed 155 motors; in the Coalinga field 42 motors. Contracts are signed for additional installations that will more than double this number.

The first motor installed in the Coalinga field was in June, 1910.

The following statement of the average daily record for electric operation in both pumping and drilling of one of the large companies in the Midway field for the month of January, 1912, is as follows:

Pumping	Meter No. 1	Meter No. 2	Total
Total kw. per mo.	26,912	20,448	47,360
No. of wells	11	10	21
Av. kw. hr. per well per day	78.9	65.9	72.1
Total product'n in bbl.	64,970	45,955	110,225
Kw. per bbl.	0.414	0.445	0.427
Av. daily production.	190.5	148.2	170.4
Av. depth wells	947 ft.	1,419 ft.	1,106 ft.
Drilling			Motor No. 3
Total kw. hours			5,770
Av. per day			231
Av. per foot			0.061
Depth			945
Grand Totals.			
Kw. hours for January, 1912			53,130
Wells pumped			21
Av. kw. hr. per well per day			72.1
Av. production, bbl.			110,925
Av. kw. hr. per bbl.			0.427
Av. daily production, bbl.			170.4
Av. depth wells, ft.			1,106

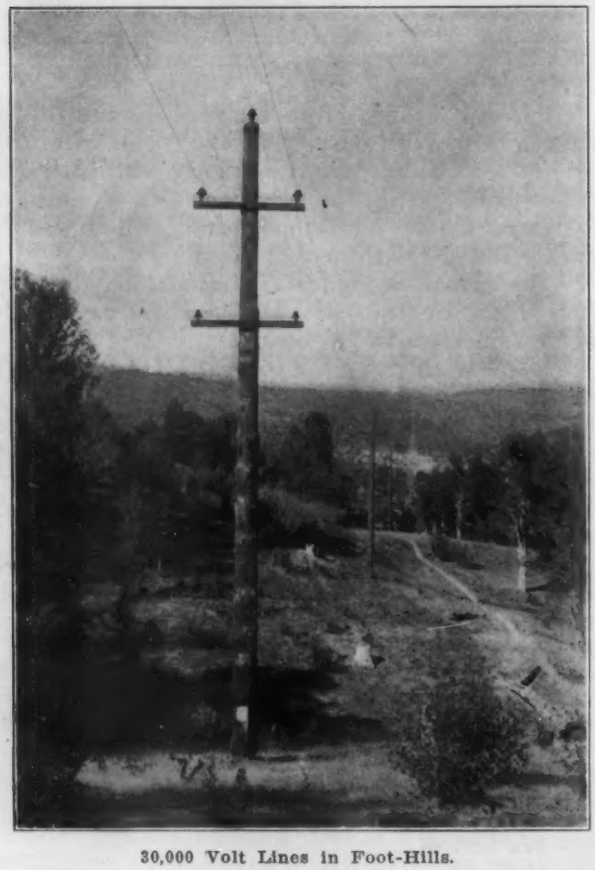
Transmission Circuits and Equipment.



Main Transmission Lines.

FOUR classes of transmission and distributing circuits have been well standardized by the company. For the long distance transmission of power between the power stations and the main points of distribution, 60,000 volt transmission has been adopted. For shorter transmissions and distribution to secondary stations 30,000 volts is used. For the distribution of suburban and town orchard pumping and oil well service 10,000 volts is employed. In some of the larger towns and cities, 2400 volts is used for distribution, in most cases being a three-wire delta connection from the transformers, but in one or two cases the 2400 volt has been star-connected to give 4125 volts.

Throughout the system all transmission and distribution lines are star-connected from the transformers, the neutrals being grounded.

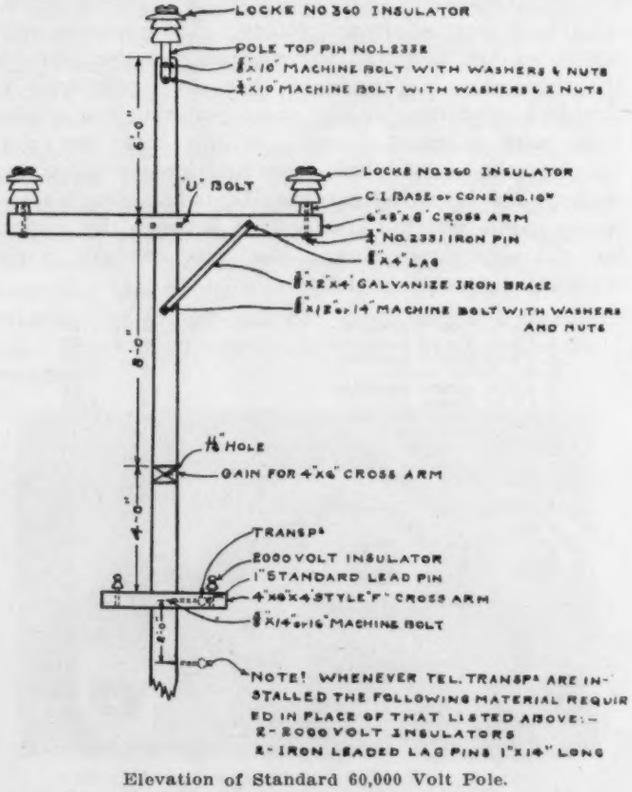


30,000 Volt Lines in Foot-Hills.

A spacing distance for poles on all lines of 15 to 16 to the mile has been adopted after a dozen or more years of experience in this section, as being economical and satisfactory under all conditions of operation. There are, of course, some exceptions to this rule in mountainous or rolling country, but by far the largest proportion of lines is in country which is practically level.

The main 60,000 volt transmission lines are mounted on 50 ft. round Washington fir poles. The wires form an equilateral triangle, two of them being at the extremities of the single cross-arm, the third wire being at the top of the pole, mounted on a malleable iron pin. Steel pins are used with lead and porcelain thimbles and standard Locke insulators. The cross-arm is fastened to the pole by the usual gain and a ¾ in. galvanized U-bolt which passes around the pole. In the mountains where trouble has been experienced by eagles in short-circuiting the lines, a novel construction, of mounting two of the insulators directly on the pole, one or either side, is being tried.

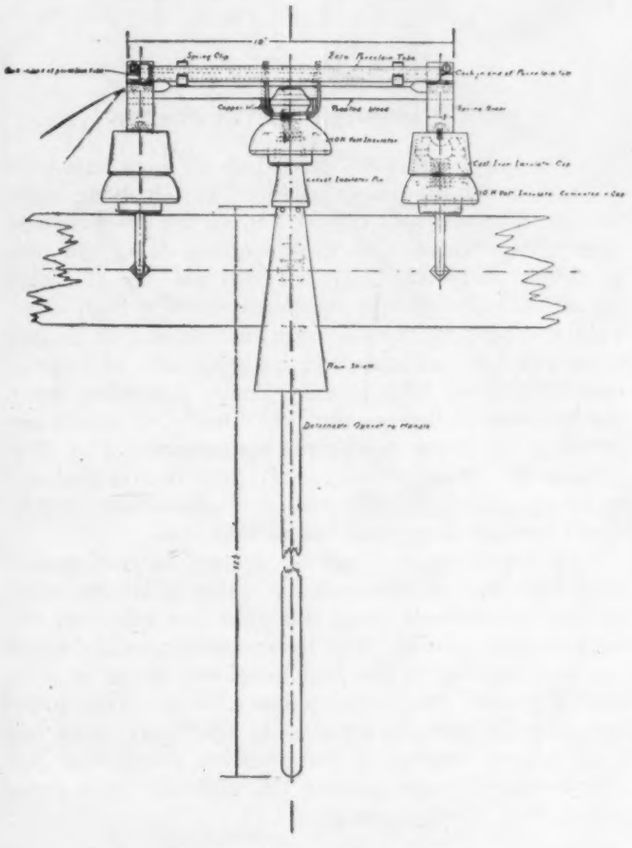
Where the circuits cross a railroad track or other wires, whether telegraph, telephone or power, a novel type of grounded cradle is used. This consists of a structural steel frame extending out from the pole a short distance below the lowest wires of the circuit. At the extremity of this cradle is a U-shaped guard to which the ground connection is made. The poles are so placed that should a wire break at any point it will fall on this cradle and be grounded and at the same time fall free from any possible contact with foreign wires.


LOCKE NO 360 INSULATOR
POLE TOP PIN NO L233E
⅝"X10" MACHINE BOLT WITH WASHERS & NUTS
¾"X10" MACHINE BOLT WITH WASHERS & NUTS
6'-0"
"U" BOLT
LOCKE NO 360 INSULATOR
C.I. BASE or CONE NO. 10"
6"X8"X8" CROSS ARM
¾" NO 2331 IRON PIN
⅝"X4" LAG
⅝"X2"X4" GALVANIZED IRON BRACE
⅝"X12" or 14" MACHINE BOLT WITH WASHERS AND NUTS
8'-0"
⅝" HOLE
GAIN FOR 4"X6" CROSS ARM
4'-0"
TRANSP.
2000 VOLT INSULATOR
1" STANDARD LEAD PIN
4"X6"X4" STYLE "F" CROSS ARM
⅝"X14" or 16" MACHINE BOLT
6'-0"
NOTE! WHENEVER TEL. TRANSP.S ARE INSTALLED THE FOLLOWING MATERIAL REQUIRED IN PLACE OF THAT LISTED ABOVE:-
2-2000 VOLT INSULATORS
2-IRON LEADED LAG PINS 1"X14" LONG

Elevation of Standard 60,000 Volt Pole.

Guying is resorted to in the ordinary manner, a wooden insulator being slipped over the guy from its point of contact with the ground for a distance up of about 12 ft. In guying fore and aft, a sling is used which is fastened near the extremities of the cross-arm but just inside of the insulator pins. Either end of this sling terminates in a galvanized ring to which the guying cables are fastened.

Both copper and aluminum wire is used on the 60,000 volt transmission lines. From the power station to the Henrietta sub-station No. 0 copper is used. From Henrietta to Bakersfield No. 000 seven-strand aluminum is used, except where entering substations, all entrance wires being of copper.



10,000 Volt Pole Line Cut-Out.

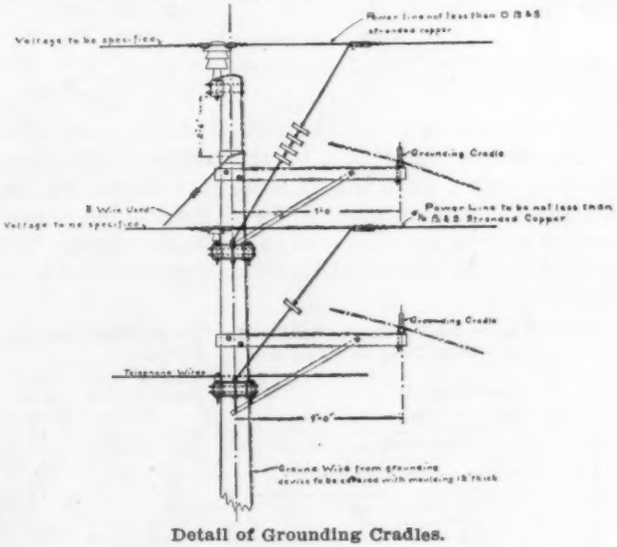
A very successful pole-type cut out for 10,000 volt circuits, mounted whenever a branch is taken from a main line, has been developed and is used exclusively by the company. This consists of a porcelain tube through which passes a fuse wire, mounted on a wooden stick either end of which has a copper blade. The blades engage jaws mounted on insulators, which in turn are held to the arm by a steel bent pin. At the center of the wooden bar on the under side is a threaded socket. In operation the lineman at some distance below all circuits inserts a long stick, the end of which has a male thread and draws the bar and fuse downward to disengage it. This device is simple and positive and costs to manufacture complete, $1.80.

The construction for the 30,000 volt circuits is in two forms. On some of the main lines feeding at this voltage, comprising the older part of the system, it is quite similar to that just described; except

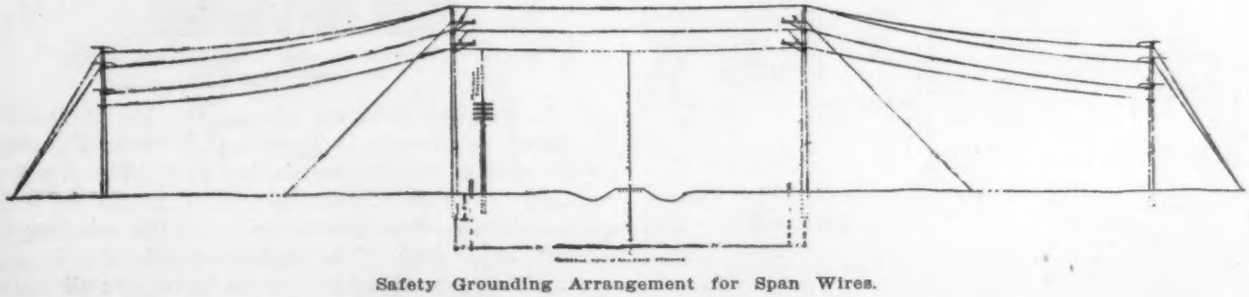
Transmission Line in Midway Oil Fields.

that the triangle is somewhat smaller. The more modern construction, which has been adopted on all of the newer lines and is now standard, is for 40 ft. poles. There is a single cross-arm placed at the top of the pole. This arm carries three insulators; one at each extremity and one in the center. The method of guying and providing for crossing foreign wires is similar to that used on the 60,000 volt lines, but somewhat smaller in general dimensions.

The 10,000 volt distribution circuits are mounted on 35 and 40 ft. round poles, and have a single four-pin cross-arm. Three of the pins carry the three wires of the circuit. The fourth, which is invariably an outside wire, is the ground wire, being the grounded neutral of the system. This arrangement has been found necessary as it is difficult in many



Detail of Grounding Cradles.



Safety Grounding Arrangement for Span Wires.

places to procure a good ground. It also saves the cost of constructing a ground connection at every transformer set. On both the 30,000 and the 10,000 volt circuits copper is used exclusively.

On the 10,000 volt distribution circuits, where there is no possible chance of extension, four No. 8 hard-drawn copper wires are used. For lateral lines there is a possibility of extension over a comparatively smaller territory three No. 6 and one No. 8 ground wire are used. On main feeders three No. 4 and one No. 6 wires are used, all being of hard-drawn copper.

To illustrate the difficulty of procuring ground connections for transformers in the west side oil field district from Maricopa on the south, through the Midway field to McKittrick on the north, a distance of 25 miles, there are but two ground connections, one at Midway and one at McKittrick. The ground connection at Midway is a 2000 ft. well in which a large quantity of charcoal was placed, but in which it is necessary to occasionally pour water to keep the ground in effective condition.

Standard insulators adopted for the various types of line are as follows:

STANDARD INSULATORS.

60,000 Volt.

Pin type	360 Locke
Strain type	273 Locke 2 units
Strain type	1060 Thomas 3 units

30,000 Volt.

Pin type	408 A Locke 1-in. pinholes
Strain type	1060 Thomas 2 units
Strain type	273 Locke 1 unit

10,000 Volts.

Pin type	298 Locke
Pin type	9046 Ohio Brass Co.
Strain type	1060 Thomas 1 unit

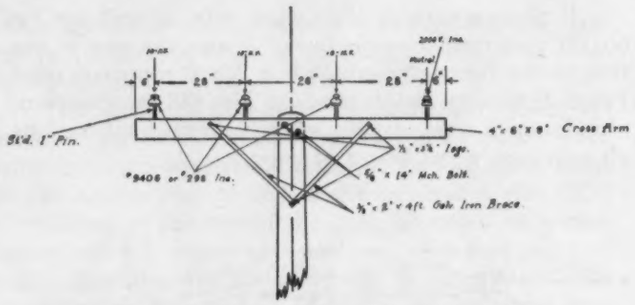
4,000 Volts and Under.

Pin type	44 Locke
Pin type	9990 Ohio Brass Co.
Strain type	2 Goose Eggs

The costs and specifications of the various types of line are carefully kept by the company and tabulated in such a form that it is an easy matter for the company's business agent to figure quickly the proper cost of making an extension to a new customer. The cost of a main section of 10,000 volt distribution is as follows:

Estimate of Labor and Material for Building One Mile of 10,000 Volt Line. With Three No. 4 and One No. 6 Wire.

No.	Name of Article	Unit Weight	Total Weight	Unit Price	Total Price
15	40-ft. poles			$11.00	$165.00
17	Style D cross-arms	64	1088	.80	13.60
51	No. 9046 O B insulators	2	102	.15	8.16
17	No. 44 Locke insulators	1	17	.037	.63
6	No. 1060 Thomas strain insulators	4	24	1.33	7.98
68	1-in. leaded pins	1¾	85	.20	13.60
34	28-in. cross-arm braces	2	68	.11	3.74
60	½x3½ lag screws	3 oz.	11¼	.015	.90
12	⅝x14-in. bolts	1⅜	16½	.044	.53
6	⅝x16-in. bolts	1½	9	.048	.29
36	⅝-in. washers		2¼	.039	.09
4	anchor rods	14	56	.75	3.00
4	anchor slugs	50	200	.50	2.00
4	anchor slugs washers	2	8	.12	.48
4	goose egg strain insulators	1	4	.07	.28
200	ft. ⅜-in. guy wire		60	.0128	2.56
8	3-bolt clamps	1	8	.201	1.61
3	miles No. 4 H D copper wire	667.4	2002	.1513	302.90
1	mile No. 6 H D copper wire	420	420	.1513	63.55
100	ft. No. 6 S D copper wire		8	.152	1.22
6	small clevises	5	3	.043	.26
6	small thimbles		1	.023	.14
					$592.52
	Delivery of poles			.90	13.50
	Delivery of material		4613		18.00
	Surveying				9.00
	Labor				120.00
					$753.02



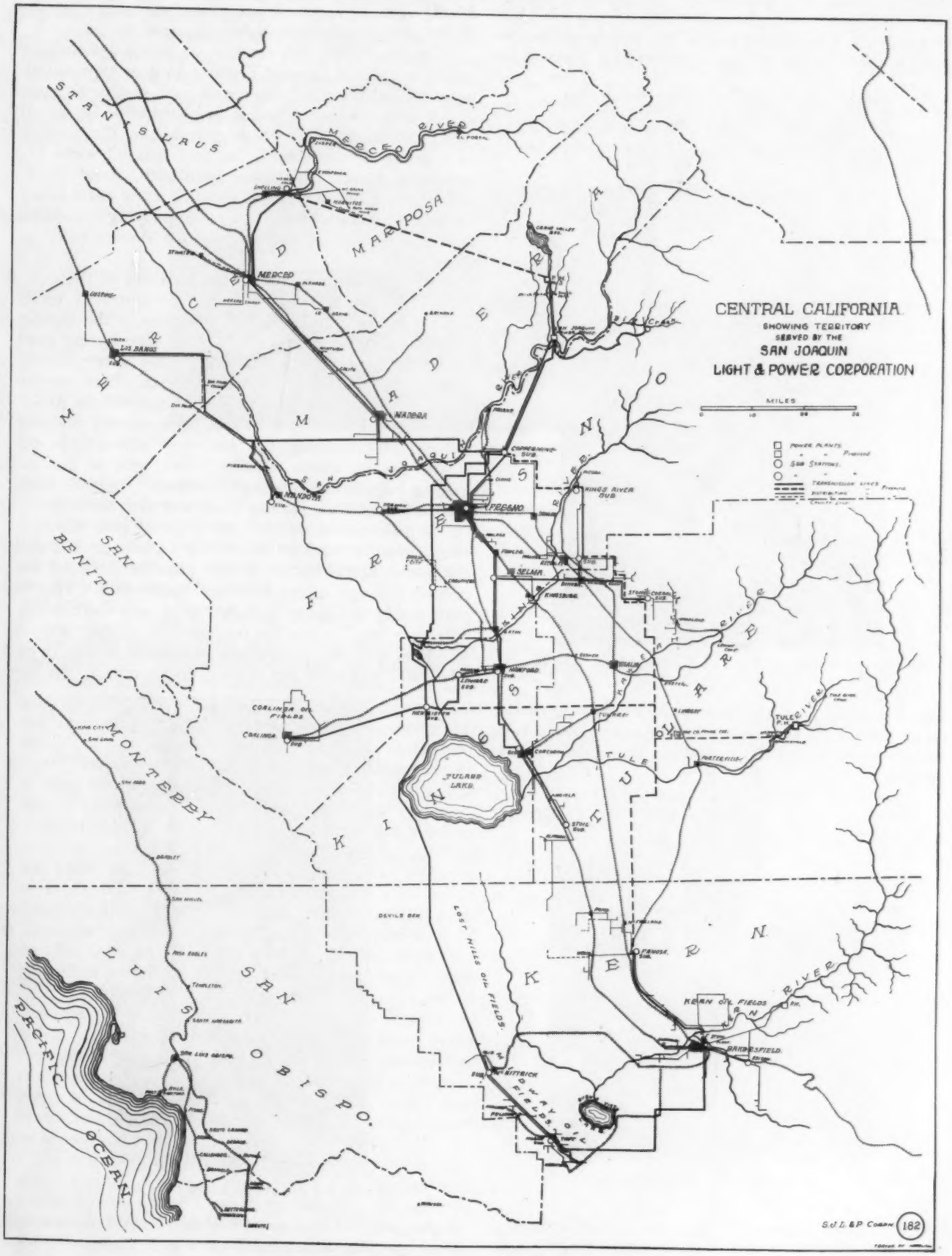
Detail of Standard 10,000 Volt Pole Top.

Telephone wires are carried on all lines on a two-pin arm under the power wires. The telephone wires are No. 8 hard-drawn copper and on the transmission lines are provided with taps running down the pole so that a patrolman may cut into the line at stated points. The telephone equipment is of a high class, built to order by the Kellogg Switchboard & Supply Company and are standard bridging sets of various resistance from 1600 to 2500 ohms, depending upon the location of the instrument. Insulated stands are provided at every telephone instrument. The telephones are mounted upon iron pipe frames and are in many cases equipped with a marble panel switchboard for operating upon the various lines.

In operating a telephone system in conjunction with high tension transmission, there is always more or less interference from the inductive effect of the high tension current. This is especially true if there is any unbalancing of the high tension circuits or accidental ground on the telephone circuit. This problem of inductive disturbance to telephone lines has been a bug-bear to all transmission companies, but this company has overcome the difficulty to a great extent in a novel manner.

Standard Transformer Mounting in Oil Fields Showing Meters.

At terminal points a standard 3 kw. 2000 volt lightning transformer is introduced between the telephone wires before leaving the last pole. The primary winding of the transformer is bridged across the telephone circuit. The center point of the winding is carried to ground. The secondary winding is left open. This grounding coil serves to remove all static

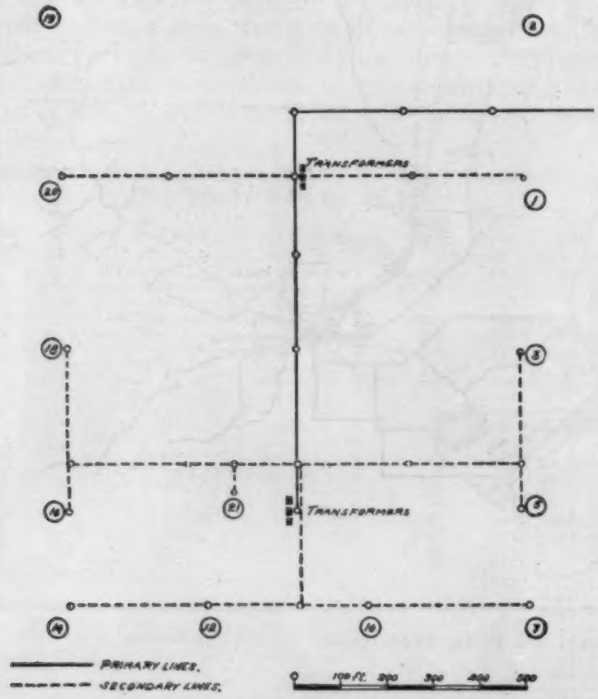


Territory Served by San Joaquin Light and Power Corporation.

potential from the telephone circuit without in any way interfering with the clearness of speech. Between these transformers and the telephone instrument are inserted fuses placed in porcelain tubes as an

Transformer Mounting for Commercial Service at Bakersfield.

added safety. This plan has worked admirably under all conditions for a number of years and seems to have satisfactorily solved the telephone difficulties for this system.



Layout for Lines and Transformers for Group of Oil Wells.

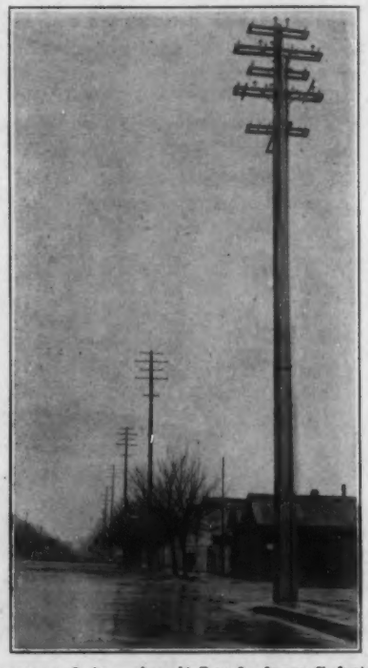
At all of the secondary substations where not over 30,000 volts is received, are placed General Electric, Wirts carbon resistance lightning arresters.

On the 60,000 volt circuits at principal switching points are placed General Electric outdoor type aluminum cell lightning arresters with horn discharge gaps.

A comprehensive system of distribution in the oil well sections is often made possible in the feeding of a group of wells from the fact that oil wells are generally placed with some regularity, about 50 ft. inside of the property lines, these in many cases being on quarter section lines. The accompanying cut shows half of a typical oil well distribution system to 22 or more wells.

In rural districts where the business of the company is both the supply of power for pumping water and for lighting and domestic purposes, if the district is sufficiently populous, a system of distributing lines along the road, which generally follow every section line, is used. It has been found that where service was introduced into a section, even against the prejudice of the inhabitants, it has been eagerly adopted not only for lighting, but for every conceivable domestic service which electric current can be put to; ironing, operating sewing machines, electric fans, washing machines, curling irons and even cooking.

Within the cities the conventional pole distribution is used for both 2400 volt 2 or 3-phase circuits and also series arc circuits. Where possible the lines are carried through alleys between the streets. This is particularly the case in Bakersfield, and here 60 ft. poles are used in the business section of the city. A standard type of transformer mounting is employed. The 2400 volt lines are carried on an arm at the top



Underground Arc-circuit Leads from Substation.

of the pole. About half way down the pole are the arms carrying the transformers and the fuse blocks are mounted on a separate arm below the transformers. The leads from the lines are brought down to the fuse blocks and then carried back to the transformers. This enables a trouble man to open the

fuse blocks and insert new fuses without danger of coming near primary wires.

Series arc systems are invariably used with 6.6 ampere alternating current. There has recently been installed in Bakersfield a new street lighting system, using magnetite luminous arc lamps in series on direct current. The General Electric type M.S. regulator with a mercury arc rectifier, the primary voltage 2200 and rectified voltage 4500 with current of 4 amp., is used at the substation for control of this circuit. Arc circuits are brought out of the substations underground in lead-covered cable and carried to the top of the first pole, standard outlet bushings being used at the top of the pole.

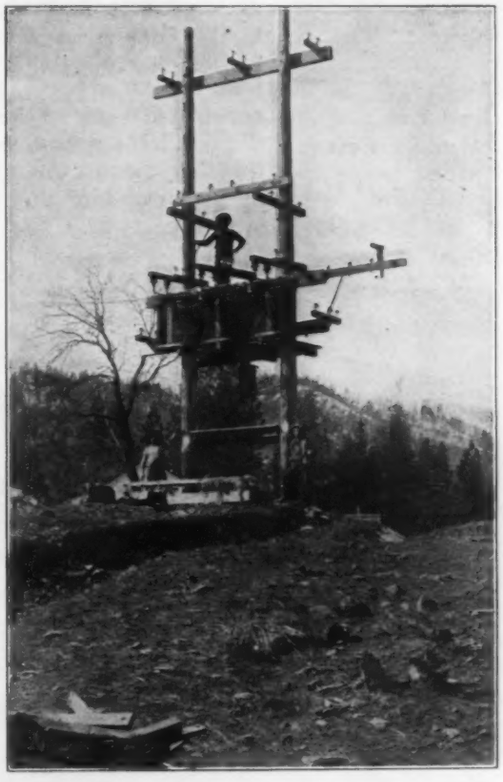
Pole Treating Plant at Fresno.

Pole Treating Plant.

During the past years of operation, one of the most serious of the depreciation charges is for the replacement or repair of decaying pole butts. In 1908 a systematic study of this subject was begun with the idea of eventually correcting or preventing the trouble if possible. The poles in use were native redwood, cedar and yellow pine and Washington fir. During this year a line 30 miles long of native yellow pine poles was set after being thoroughly seasoned. Part of the poles were given a brush treatment of carbolineum and with creosote, the remainder received an open tank treatment of creosote, zinc chloride or crude oil. Stubs of untreated timber were set at intervals along the line for the purpose of comparative observation. In June, 1910, after a period of 27 months the line was inspected with the result that the untreated stubs were found to be completely rotted. The brush treated were found to be in a greater or less condition of decay, those treated with crude oil being in somewhat better condition than those given the carbolineum or creosote coat. About one-quarter of the poles given the zinc chloride treatment showed signs of decay while 50 per cent of the entire line which received the open tank creosote treatment were in sound condition.

On the results of these tests an open tank creosote treating plant was erected at Fresno in 1911 and all of the poles now used on the system undergo this treatment, but for the butts only.

The plant covers about four acres adjacent to the railroad at the outskirts of the city and comprises a yard for storage of both treated and untreated poles. Poles to be treated are raised with a derrick operated through a double drum hoist by a 15 h.p. Western Electric induction motor. A 50 h.p. tubular boiler furnishes steam for heating the creosote bath. The treating plant consists of two square steel tanks placed at either end of a concrete trough, these are connected by a series of pipes and valves and supplied from large steel storage tanks placed in the rear. The pole which must be dry is lowered into the tank containing hot creosote. This for Washington fir is heated to 212 degrees F. and the pole remains in this bath for four hours. It is then placed in cold oil for an additional period of three hours and the resulting penetration is about three quarters of an inch. With yellow pine the penetration is greater, in some cases extending almost to the center of the pole.



10,000 Volt Transformer Mounting.

Sierra Nevada Mountain Summit.

Hydraulic Development and Power Plants.

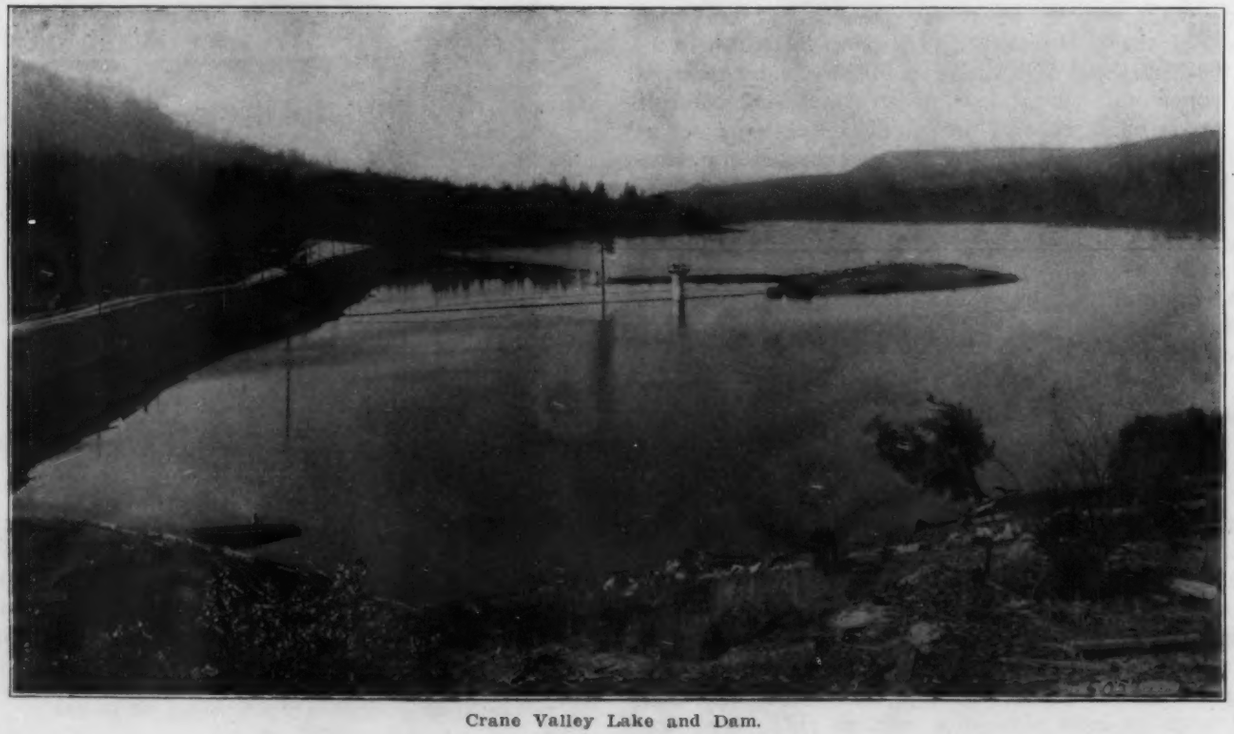
Waste Weir No. 3 Canal.

THE water supply for the system, as operated at present, is derived from the north fork of the San Joaquin River. This supply comes from the water sheds of two tributaries to the north fork, the north and south. In 1909 it was decided to erect an immense dam at the site of the then existing dam in Crane Valley, this valley being part of the north fork of the stream. There were a number of serious problems to overcome in the construction of so large a dam and the entire matter, together with the reconstruction of the old canal system and of the No. 1 power plant, was placed in the hands of J. G. White & Company of New York.

As completed, this dam has a total length on the top of 1860 ft. The height above the lowest point of the canyon is 150 ft. the crest width of the earth fill section is 30 ft. and of the rock fill section 15 ft. The corewall of 1 to 2½ to 5 concrete extends throughout the length of the dam at its center. On the upstream side of this corewall the dam is a hydraulic earth fill. On the down stream side it is a rock fill construction.

In building the corewall the native granite was thoroughly exposed and a trench was made 10 ft. deep. The concrete was built into this trench and the wall gradually tapered until a width of 2 ft. was obtained at the crest. The batter on the down stream side is 1:50 and on the other side 1:75. The corewall is reinforced with 1 in. plain square bars at the bottom and these decrease in size until at the top the bars are ⅜ in. Great care was taken that the base of this wall should form an absolutely water tight joint with the native rock.

In building the hydraulic fill on the up stream side earth suitable for this work was found near the dam. This material consists of coarse disintegrated granite



Crane Valley Lake and Dam.

with red clay and adobe, which, when mixed, form a very solid embankment. The impervious clay material was carefully placed next the corewall while the coarser granite material was placed farther out from the wall.

Conduit No. 3 Line.

Water for hydraulic purposes was brought from a point about 6 miles away through ditch and flume and was delivered to the nozzles of the hydraulic giants under a pressure of 150 lb.

A large quarry was developed at the eastern extremity of the dam and rock was transported on trestles from which it was dumped in place in front of the corewall. Much of the rock was carefully placed by hand so that a compact fill was obtained. In proceeding with this work it was found possible, using two shifts, to deposit 19,000 cu. yd. in one month.

The configuration of the ground surface was such that it was not necessary to place a spillway in the dam proper. This spillway has been placed in an adjoining canyon east of the dam. The sill of the spillway is at an elevation 8 ft. below the high water level of the reservoir. The spillway has a length of 70 ft. between the end abutments and there is a pier in the center which supports the heavy timber framework of the structure. There are 12 gates in which are placed 3 in. planks to regulate the height of the spillway. These gates are 6 ft. wide and are constructed to hold the water level 9 ft. above the sill if necessary. The waste-way is cut out of solid rock but has a concrete floor at the sill.

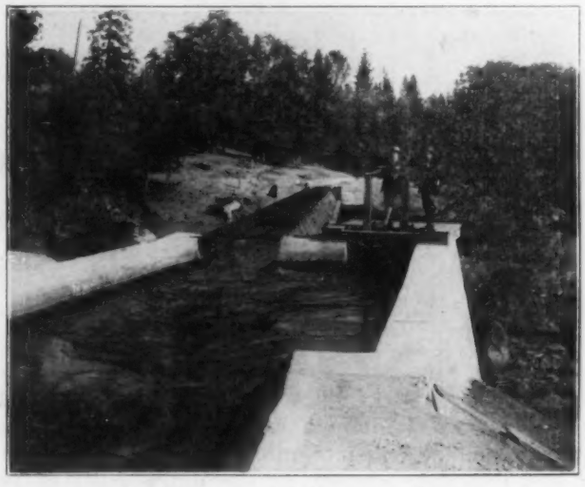
The reservoir formed by this dam is about 5 miles long. It contains 51,000 acre ft. and catches the run-off from 52 square miles, adjoining the north fork, and 26 square miles of the south fork. The reservoir area itself is 1200 acres.

During the construction of this reservoir there was cleared off 3,500,000 board ft. of lumber. Part of this was used in construction work. The remainder was shipped out in the returning freight wagons.

For controlling the outlet of water into the canal system a concrete tower has been erected in the reservoir, outside of the upper toe of the dam. This tower opens into a horizontal tunnel 722 ft. long, which is carried through the rock under the dam and into a concrete basin below the dam, on one side of which is contained an Ogee overflow wier. The gates allowing the flow from the reservoir into the controlling tower are operated through bevel gears placed on the top of the tower structure. These gates are placed at different heights, so that by proper manipulation, water may enter the tower from the surface only, at any elevation of the reservoir level.

Storage water from the reservoir enters the conduit system, which consists of a series of canals, tunnels and flume trestles, covering a distance of 4.22 miles, and is delivered into the regulating reservoir of No. 3 power house. The canals are in earth and have a trapezoidal section, the sloping sides being 1 to 1, the width of the bottom for part of the distance being 5 ft. with a grade of .15 ft. per 100 ft. and the remainder 6 ft. with a grade of .1 ft. per 100 ft. The depth of the excavation is 3½ ft. and the canal is given a 3 in. lining of concrete. The tunnels, four in number, are 5 ft. wide, 6 ft. high, with a semi-circular roof and are concrete lined. They are built on a grade of .3 ft. per 100 ft. There are 13 semi-circular steel flumes 6 ft. in diameter, which are given the same grade as the tunnels. These flumes are somewhat novel in construction, being of ⅛ in. riveted sheet steel and are supported on timber cradles and bolsters which in turn are carried by standard 4 pile trestle bents. Expansion and contraction are provided for by an unriveted slip joint. This joint is bridged on the outside with a strap of heavy canvas which is held in place by a steel strip at either end. This homely device has proven economical and efficient. The capacity of this conduit line is 100 cu. ft. per sec. The tunnels and trestles comprise 27 per cent of the distance between the dam and No. 3 regulating reservoir.

After being discharged from power house No. 3 the flow is allowed to pass down the canyon of the north fork to a point near the junction of that stream and the south fork, where a small diversion wier of concrete serves to form a pond from which the No. 1 conduit system is supplied.

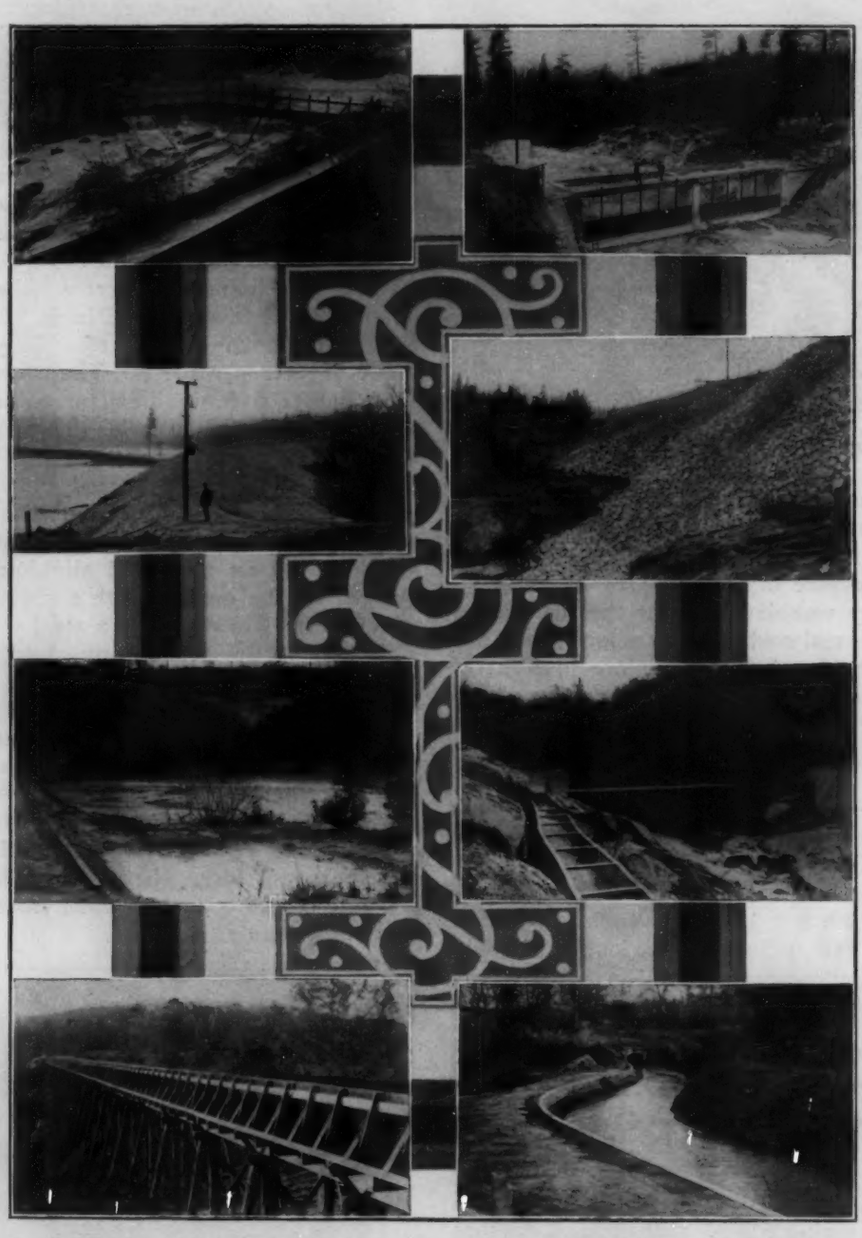


Metal Flume and Spillway No. 3 Line.

In this system there are 16 tunnels, having an aggregate length of 10775 ft. These tunnels are lined with concrete, 5 ft. wide and 6 ft. high, the top being semi-circular. There is 12,300 ft. of canal in earth and

715.5 ft. of concrete flume, at points where it would be difficult to maintain an earth canal.

Where canyons are crossed the semi-circular riveted steel flume mounted on timber cradles and conventional trestle construction are used. This canal should be of particular interest to California engineers as a departure in the practice of building canals as ordinarily understood on the Pacific Coast. It was found that to maintain a canal in the natural material, which is a disintegrated granite, was a more or less uncertain matter, as the outer walls of the canal were not only unstable, but were frequently attacked by burrowing rodents. After considering the problem of a proper construction thoroughly and the absolute necessity of maintaining the flow during reconstruction, it was decided to build a corewall in the outer bank of the canal. Accordingly a trench 2 ft. wide was dug in this bank and carried down to about 1 ft. below the bottom of the canal. Wooden forms were used in building the corewall and were placed in the trench, being held by the earth. The bottom of the corewall was allowed to spread out but the wall itself has a thickness of 6 in. and is carried well above the berm of the canal. This wall is reinforced with 3 in. x 12 in. mesh No. 6.10 gauge Clinton woven wire cloth 7 ft. wide.

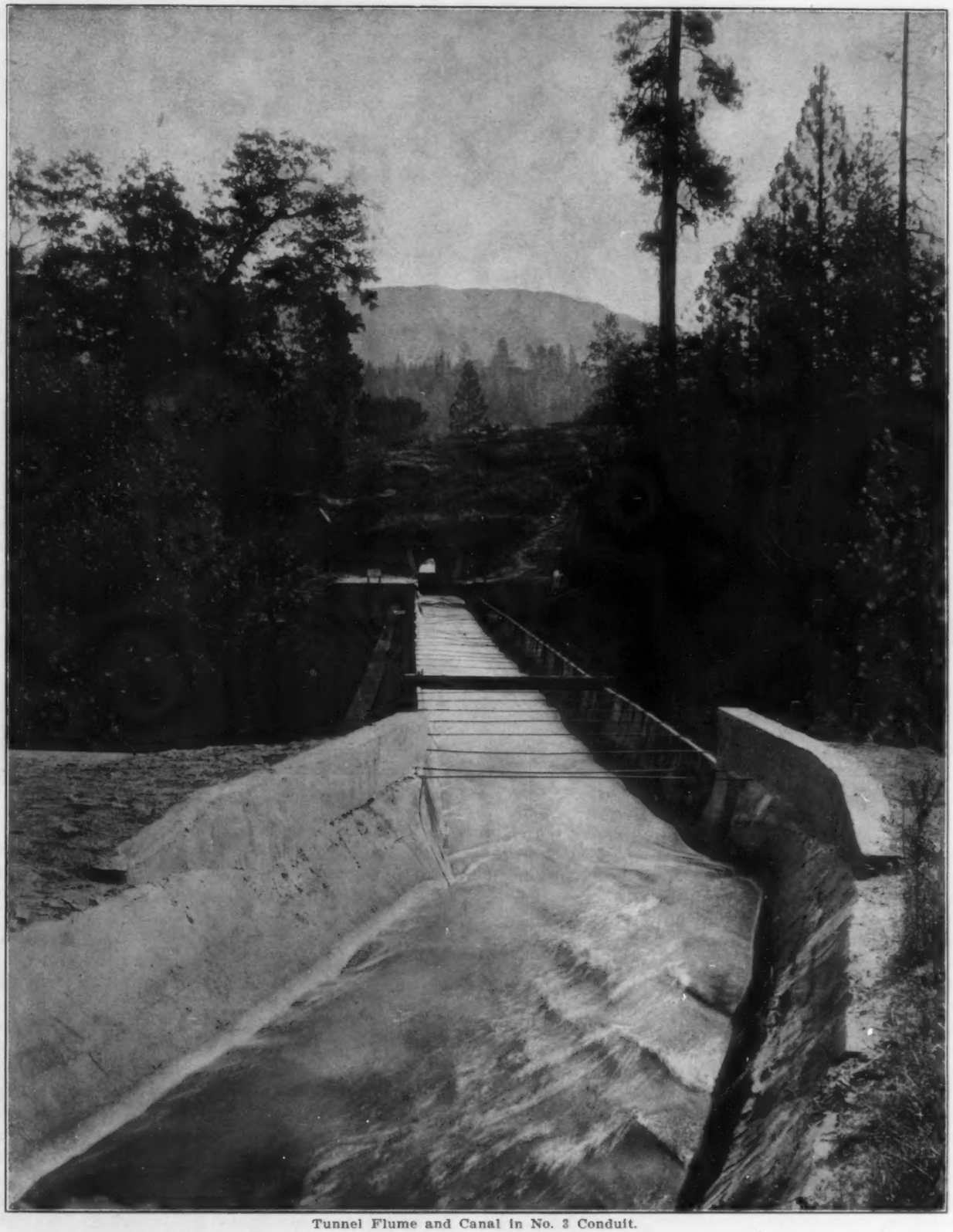


Diversion Dam for No. 1 Conduit.
West End Crane Valley Dam.
Settling Basin No. 1 Conduit.
Trestle and Steel Flume.

Spillway Crane Valley Dam.
Diverting Dam and Concrete Flume.
Downstream Face Crane Valley Dam.
No. 1 Conduit.

There are two points where the canal is carried into gulches which by cross embankments, form small settling reservoirs of about one-third acre each. The embankment was constructed as a submerged rock-filled crib, the face being tightly sheeted and conventional corewall brought up above the ground surface.

In the south fork of this branch is a concrete diverting dam from which the water is carried into



Tunnel Flume and Canal in No. 2 Conduit.

one of the settling basins already mentioned. This dam has a length of 110 ft. and a height of 20 ft. It has a vertical wall on the down stream side and a slanting wall on the up-stream side. At the west end of this dam is a single outlet gate 6 ft. wide and from this outlet a concrete flume is carried along the side hill to deliver the flow into the setling basin. This concrete flume is 5 ft. wide, and 5 ft. deep. The side walls are 6 in. thick and are reinforced like the canal corewall. The bottom is laid directly upon the prepared rock surface.

In the reconstruction of this line tunnels were employed wherever possible to shorten the line.

The canal is carried to the end or spur of the

Forebay Reservoir at Power House No. 3.

mountain, which divides the north fork from the main San Joaquin River, and delivers its flow into an 8-acre forebay reservoir constructed at a most convenient point for power development. It is oblong in shape and was formed by throwing up a simple and inexpensive earth embankment along one side. It has a capacity of 35 acre. ft. The location of this reservoir is not only unusually convenient, but is picturesque in the extreme, and a remarkable view of the surrounding canyons and mountains of the San Joaquin River and its branches may be obtained from this point.

A fall of — ft. from a diversion in the south fork tc the Crane Valley reservoir, and the drop between Power House No. 3 and the intake of the second canal of — ft. form the sites for two new power installations to be developed in the near future.

No. 3 Power Plant, which at the present time is the highest in the system, is supplied through a tunnel from the regulating reservoir at an elevation of about 20 ft. below the high-water level. In this tunnel is placed a taper pipe for a length of 20 ft. varying in diameter from 60 in. to 52 in. and 3/16 in. thickness. After passing through a gate valve the main pipe line 52 in. in diameter extends to the power house, a distance of 3,131 ft. The fall at this point is 401 ft. The pipe varies in thickness as follows: 1141 ft. of 3/16 in., 170 ft. of 7/32 in., 160 ft. of ¼ in, 680 ft. of 5/16 in, 320 ft. of ⅜ in., 100 ft. of ½ in.

There are a number of spring relief valves provided. The pipe is buried at least 18 in. below the surface of the ground and is anchored at intervals in concrete abutments.

The feeder pipes to supply the water wheels are taken off the main pipe at right angles and pass below the floor of the building, terminating in deflecting needle nozzles.

The plant is equipped with two main generating units. The generators are Bullock 1000 kw. 300 r.p.m. They generate 3-phase current at 550 volts. The armatures are Y connected with grounded neutrals. An unusual and somewhat unsatisfactory expedient is adopted with these machines in that the exciters are mounted on the generator shaft and stand between the main generator and one of the main bearings. The exciter is a 6-pole 125-volt d.c. generator. There are two overhung Doble tangential water wheels in sheet-steel housing, one at either end of the shaft. These are controlled by a Lombard type Q governor which in turn is operated by an oil pump belted to the generator shaft. The switch board contains 4 vertical panels and a 4-panel bench board and is equipped with Westinghouse and Wagner instruments. The 30,000-volt Kelman high-tension oil circuit breakers, of which there are three sets, are ope-

rated from levers mounted on the bench board. These high-tension circuit breakers are themselves mounted on steel brackets fastened to the rear wall of the building and the high-tension wires are mounted on insulators supported from steel brackets above the circuit breakers.

A 20-ton Maris traveling crane operates throughout the length of the building.

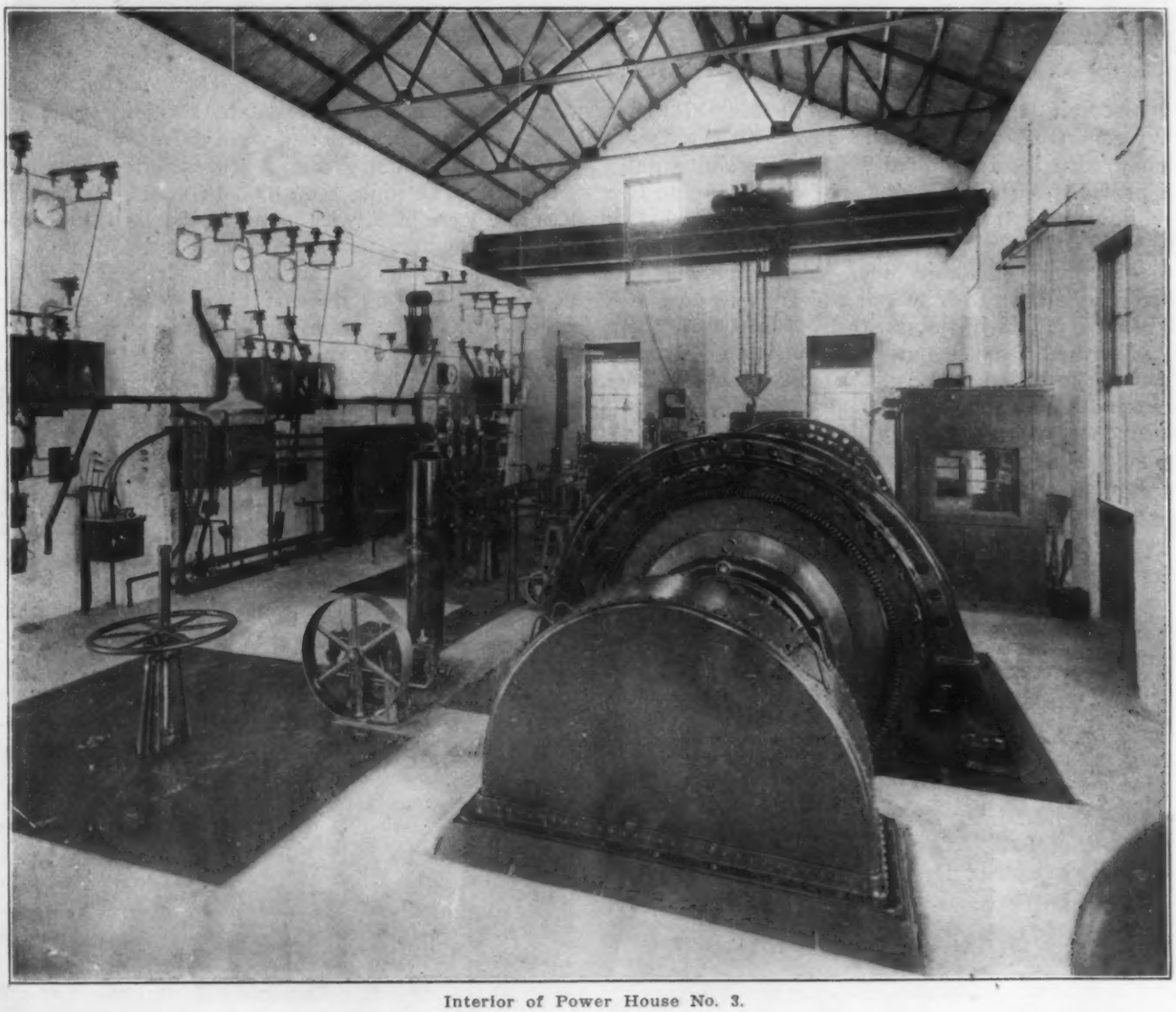
The building is of concrete 36 ft. wide and 65 ft. long. The walls are 14 in. thick with buttress columns which support a reinforced concrete crane rail integral with the walls.

The roof is of corrugated iron supported on steel Fink trusses and steel purlins. The transformers, 7 in all, (1 being a spare) are contained in separate concrete compartments adjoining the rear wall of the building. These transformers are of the Bullock 350 k.v.a. type and are water cooled.

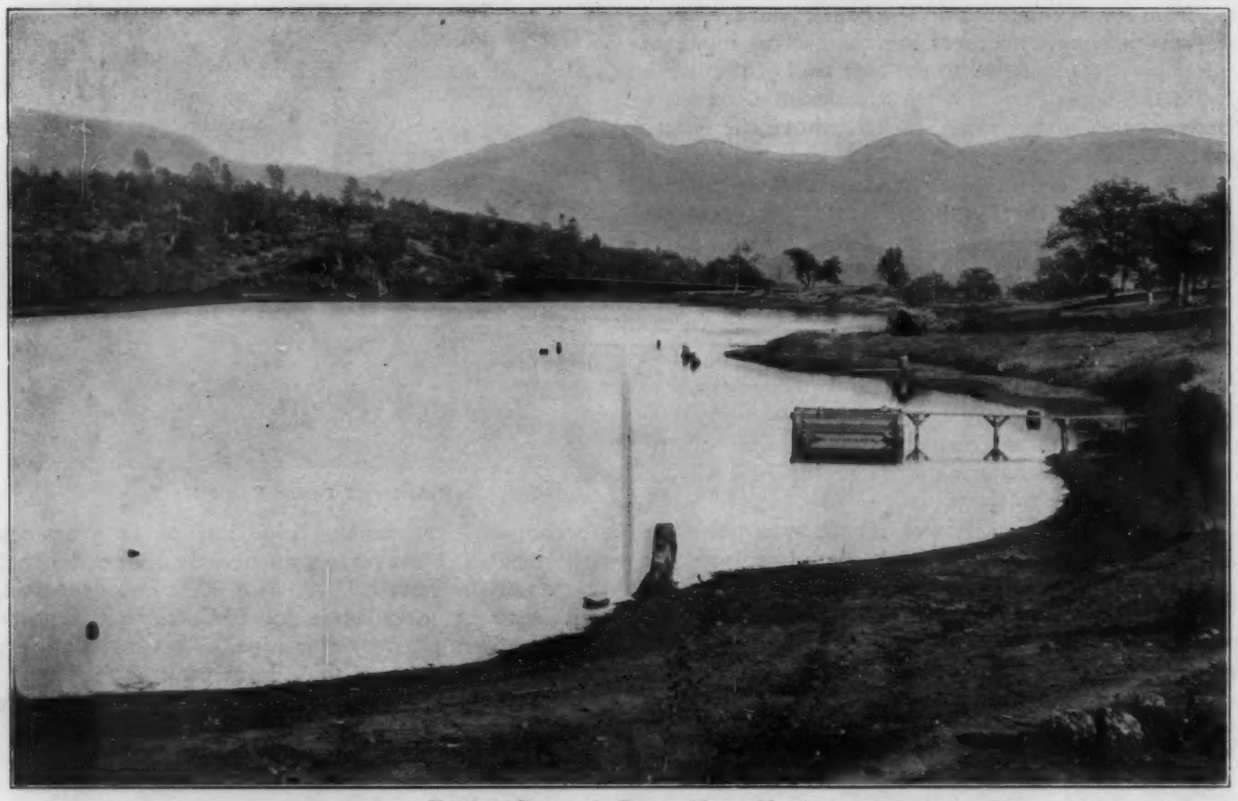
Exterior of Power House No. 3.

San Joaquin No. 1 Power House was placed in full operation in the summer of 1911 and replaced the original plant built in 1896 which was famous in its dau for the high head employed and as one of the history-making power plants during the development period of long-distance transmission. The old plant has been dismantled and the building is used as a storehouse. The famous pipe line of 18 years ago still remains, however, in apparently as good condition as when installed. A new 3000 kw. generating unit is to be installed in an addition to the power house and supplied by this pipe. This installation is to be used only on a 4 to ½ hour peak of the load.

Water for the new plant is taken from the fore-



Interior of Power House No. 3.

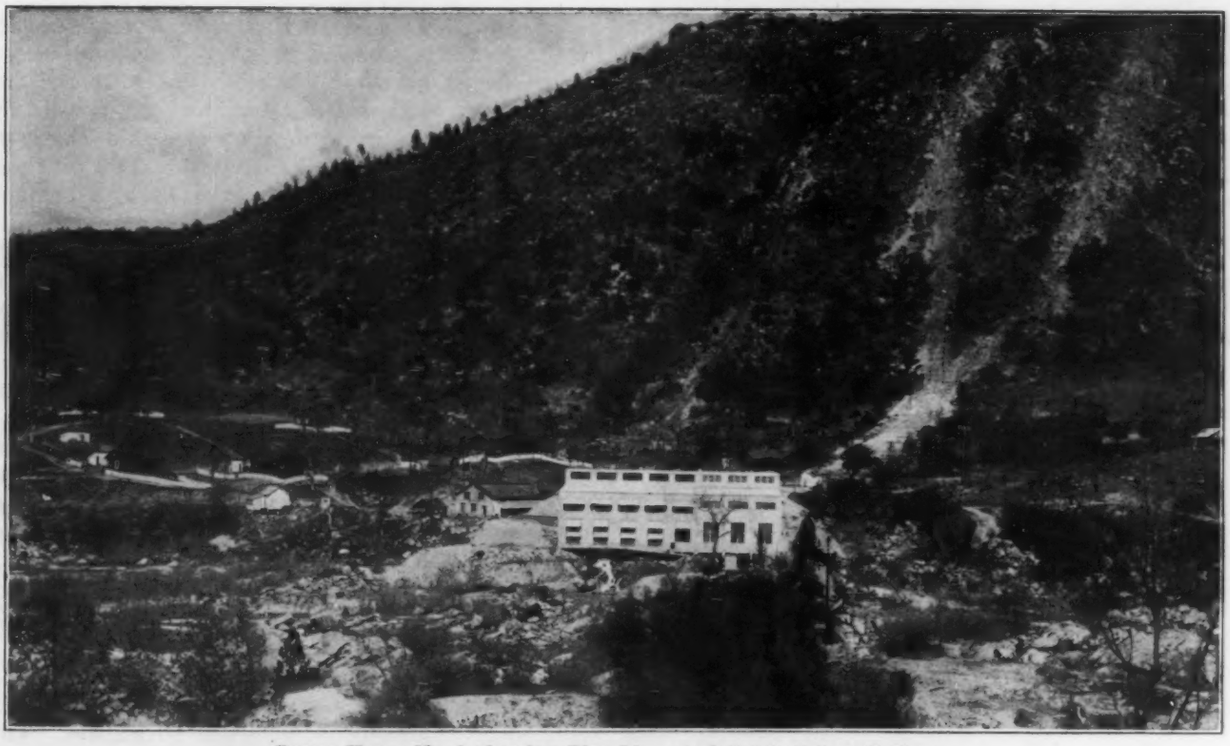


Forebay Reservoir Power House No. 1.

bay reservoir at a point on its south side through a heavy concrete head works. This consists of a double forebay with hand operated screw-stem sluice gates and provided with fine and coarse screens. The two pipe lines lead from this forebay and immediately take their course, which is somewhat diverging, down the precipitous mountain side. The pipes are well buried throughout their length and are anchored at a number of suitable points with heavy concrete piers placed in the bell holes excavated for riveting the pipe seams. The steepness of the mountain side and its rocky and generally rough character made the installation of these pipes a difficult feat. In addition it was necessary to do the work under the hot sun during the summer months when the men were constantly menaced by rattlesnakes which persisted in falling into the pipe trenches and necessitated the entire attention of one man to kill them and warn those working.

The maximum grade on the mountain side is 77 per cent. The pipes were laid beginning at the bottom and were filled with water as the work proceeded in order that the temperature of the metal might be kept as nearly uniform as possible. It was furnished in lengths of 30 ft., the maximum weight of sections being 10,000 lb. A tramway was built to assist in the delivery of pipe to the trench. Both pipes have a diameter of 34 in. at the bottom and a thickness of ¾ in. and are lap welded. This diameter increases and the thickness decreases as the pipe proceeds up the hill until at the top the former is 44 in. and the latter ¼ in., the greater part of the pipe being lap riveted. Near the top a Venturi meter equipped with

Penstock Intake and Gates for No. 1 Power House.



Power House No. 1 Showing Pipe Lines and Original Installation.

an automatic recording device was installed in one of the pipe lines. The pipes, as they approach the power house, are deeply buried and anchored in solid concrete. They enter the building below the floor line and branch, each branch going to one of the four main water wheels.

The older pipe line is 24 in. in diameter and varies in thickness from No. 12 B. W. G. at the top to 20 in. at the power house, 5/8 in. thick and 4,077 ft. long, including a 30 in. diameter receiver.

Pipe connections to operate the two water driven exciter sets are taken from each pipe line. These 10-in. extra heavy steel pipe connections are brought first to the ground surface. A system of 4 cross gates and fittings makes it possible to feed either or both exciters from either or both pipe lines. A tap is taken out to supply a tank from which water for cooling the transformers is taken. This tap contains an automatic valve which keeps the tank full of water at all times.

The power house building is 148 ft. long and 71 ft. 6 in. wide. It is a heavy steel frame structure covered with two layers of Hyrib expanded metal and Portland cement plaster 1½ in. thick. This method of building a double wall insures a dead air space and tends to lower the summer temperature, a necessary feature in this locality.

The steel frame consists of three lines of columns, two of them being along the front and rear of the building, the third down the center. Between the front and center line is the main generating space. Between the center line and the rear is the space occupied by transformers, switch board and ample storerooms on the main floor and on the second floor by the high-tension switching gallery of which there are two sections. An all electrically driven traveling crane operates the length of the generating bay.

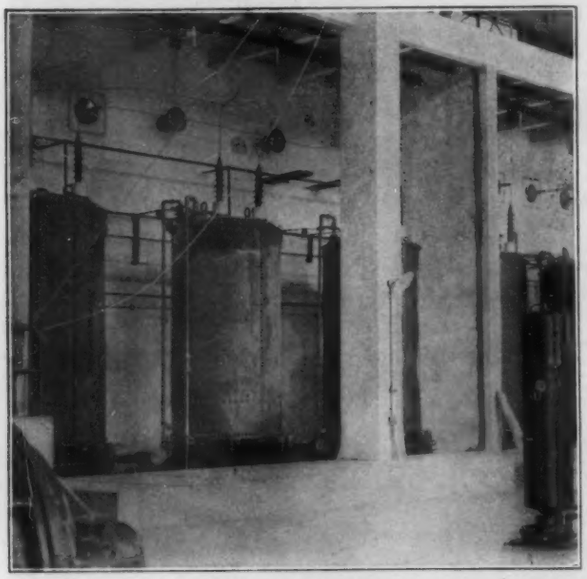
There are four main generating units. The generators are General Electric 4,000 k.v.a., 2,300 volt, 3-phase, and operate at 400 r.p.m. The water wheel is a single overhung Doble runner enclosed in a cast-iron housing and is equipped with two needle nozzles. The upper or main nozzle is operated by a type Q Lombard governor. The lower nozzle is a by-pass and opens when the main nozzle closes, thus removing the water from the wheel without shock to the pipe lines. The automatic mechanism gradually closes the by-pass needle so that water may be conserved when it is not in use on the wheel.

There are three exciter sets, the generator in each case being a General Electric type M.P. 6 pole, 100 kw., 900 r.p.m., 250 v. d.c. machine. One set is driven by a Doble overhung water wheel at one end of the generator shaft and a 150 h.p., General Electric type I induction motor is at the other end. The second exciter set is similar but has no induction motor. The third exciter set is similar to the first described, having the induction motor, but no water wheel.

A three-crank oil pump driven by a 1½ h.p. General Electric induction motor circulates oil to the transformers. There is also provided one 2-cylinder air compressor driven by a 4 h.p. General Electric induction motor. The transformers occupy four compartments open to the main bay but enclosed in concrete walls on the other three sides. In each compartment are three 1500 k.v.a. General Electric transformers mounted on 4 wheel steel trucks which in turn rest on rails in the concrete floor and permit the transformer to be moved out into the main bay so that it may come under the traveling crane. The transformers are wound for a star connection of 69,450 volts, are water cooled and the tanks are connected through a system of piping to a concrete oil sump-tank which is placed

below and outside of the building. Connection is also made with a steel tank which holds enough oil for one transformer placed below the main station floor.

The switch board supplied by the General Electric Company is of black slate in 17 vertical panels, which



Bank of Transformers.

control four generators, two exciters, 1 Tirrill automatic regulator, four transformer banks and the remainder for high-tension lines. Indicating and graphic recording instruments are provided in accordance with the most modern practice.

The 2,300 volt generator and transformer switches are placed in concrete cells directly in the rear of the switch board so that the connection between the operating handles on the switch board and the switches is entirely mechanical.

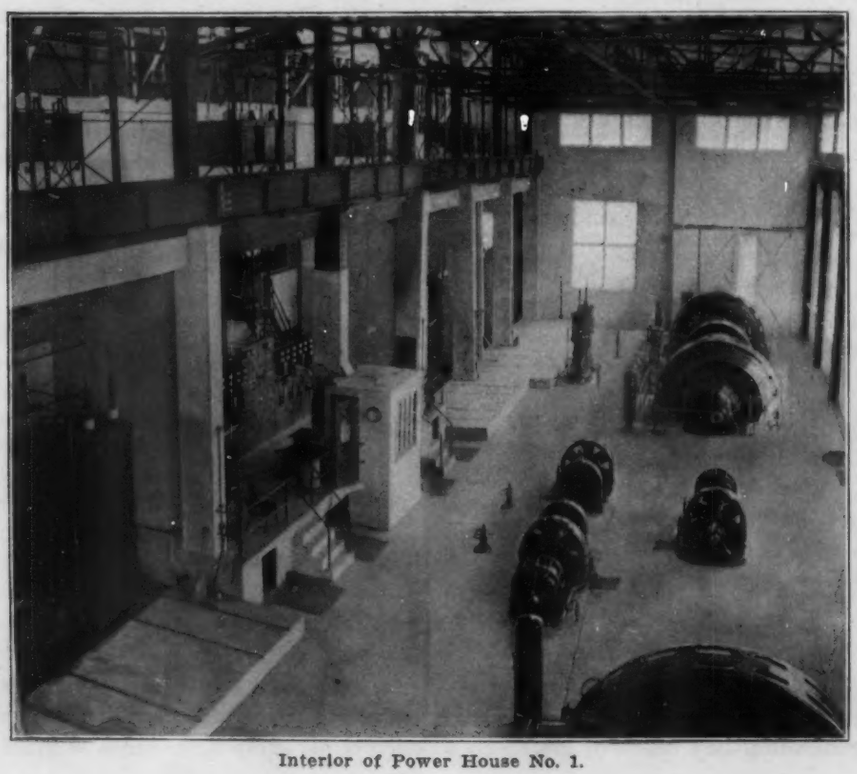
The high tension circuit breakers were supplied by the Kelman Manufacturing Company and are arranged in two rows. Between these rows are two parallel fireproof walls and between these walls the high tension leads from the transformers are brought up and then branched to the circuit breakers on either side. The space between these walls also contains series and shunt transformers.

There are two sets of high tension bus lines, each set being divided at its center point where a Kelman oil circuit breaker is placed. There are altogether 18 sets of high tension circuit breakers, each set being equipped with knife blade disconnecting switches. There is provision for six outgoing transmission lines, although but four are at present installed.

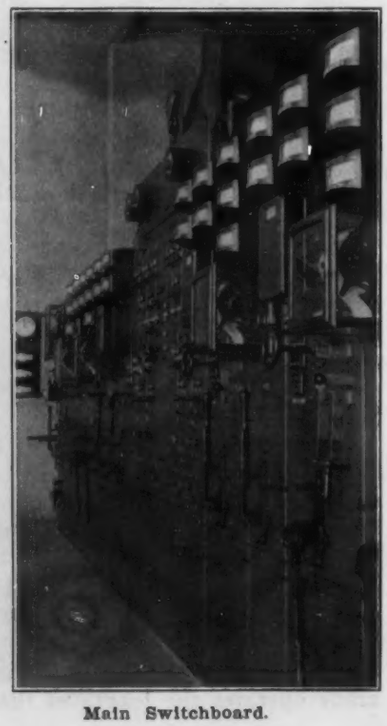
The method adopted by this company in carrying 60,000 volt lines from the building is unique. A Locke wall insulator mounted in a concrete slab is placed on an angle to an opening in the building wall of about 45 degrees. Above this is a lean-to roof, the whole being structurally connected. All of the high tension wiring, switches and insulators are mounted on structural steel framework.

This building contains no wood or inflammable structural material of any sort, the window frames being of steel and the windows of wire glass. This power house has a total capacity of 20,000 h.p. The hydraulic head is 1420 ft. The discharge from the plant is directly into the San Joaquin River. The lines leading from the plant are provided with General Electric outdoor type aluminum cell lightning arresters, equipped with horn gaps.

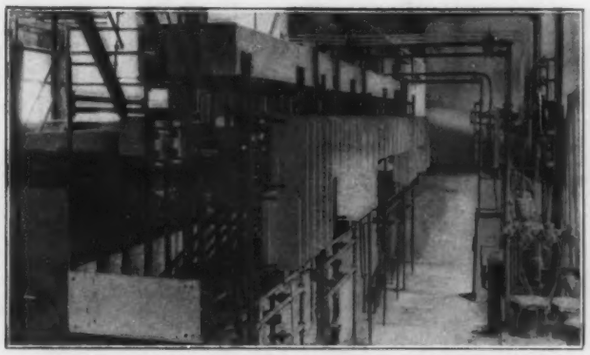
Kern Canyon Power Plant.—The Kern River emerges from the canyon through an opening in the sheer side of the mountain that appears as though it might have been cut by some gigantic ditching machine. It is V shaped and extremely rough, the pre-



Interior of Power House No. 1.



Main Switchboard.



23,000 Volt Generator Switches and Disconnectors.

cipitous mountain sides being strewn with jagged ledges and great granite boulders. About two miles above this mouth a granite ledge forms a natural dam across the river. On the north side and about 50 ft. back of this ledge is the opening into the tunnel which carries water to the power plant. This opening is covered by a grizzly of heavy iron bars, and within it is placed a sluice gate to shut off the flow, this tunnel opening being at all times submerged.

This plant is one of the first hydroelectric plants to be installed in California, and, while small, has had an interesting history. When first constructed, water was carried from the point of diversion along the face of the rocky cliff in a wooden flume. The high factor of depreciation and the danger of breaks with resulting interruptions in the operation of the plant made its abandonment advisable, to be replaced with a tunnel 8,500 ft. long, driven through the solid granite mountain. This tunnel is 8 ft. wide and 7 ft. high and has a gradient of 0.32 per cent. It is lined with concrete, and terminates at the head of the pipe line as did the old flume.

After leaving the tunnel the water passes through a 5½ ft. diameter hydraulic piston operated gate valve and thence into the pipe line. This pipe is not buried but rests on the surface of the ground, being anchored at a number of points with steel cables turned about the pipe and fastened into concrete piers. The pipe has a diameter of 66 in. and varies in thickness from ¼ in. at the top to ⅜ in. at the bottom and has a length, including the receiver, of 4,077 ft., and the total drop is 1,411 ft.

The power house is a frame structure at the river's edge just outside the canyon and contains three General Electric revolving field 450 kw., 3-phase generators driven at 257 r.p.m. through a flywheel coupling by Knight water wheels.

Water from the receiver is carried to the water wheels after passing a hydraulic operated gate valve. These valves are operated from a bench board near the main switch board, each by a brass handle and dial, as is also the gate at the top of the pipe line. Between the hydraulic gates and the water wheel are butterfly valves which are operated by a cast-iron hand wheel and column.

There are two exciters, the generators of each being General Electric 17.5 kw. operating at 1,100 r.p.m. One of these is driven by a Pelton triple runner water wheel, the other by a Knight single runner wheel.

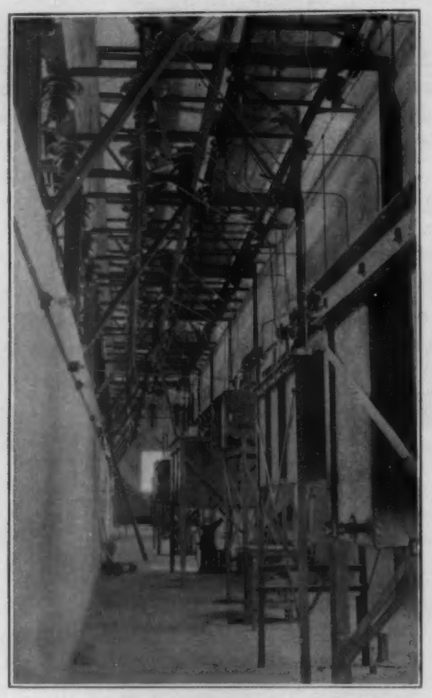
Pipe Line and Kern River Power House.

The switch board has 8 panels, 3 for transformer circuits, 1 for exciters, 3 for generators, and 1 for voltage regulator.

There are nine General Electric transformers, six of them are old style air cooled 160 kw. capacity with a voltage ratio of 500 to 10,000. The remaining three are of the newer vertical type, also air cooled, and are of the same capacity and voltage ratio.

Intake Kern River Plant.

Two rotary blowers driven by water wheels furnish the air for cooling the transformers. A third blower furnishes air which is driven into the revolving armatures of the generators for cooling, there being seasons of the year when the temperature at this plant becomes excessive.



Kelman 60,000 Volt Switches in High Tension Gallery.

A two-circuit transmission line conveys the current to Bakersfield, where it is synchronized with the other 10,000 volt circuits in this district.

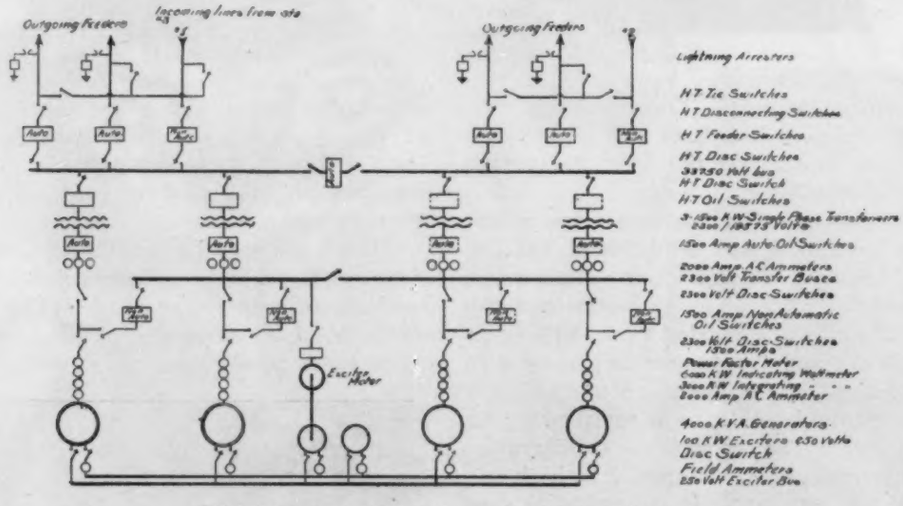
Steam Power Plants.

Boilers, Bakersfield Plant.

FRESNO Power Station—The steam power plant in the city of Fresno acts also as a substation for the distribution both of the local city system and for a number of outgoing branch circuits which cover a large territory. This station adjoins the tower of the water works. The power station is inclosed in a substantial brick building containing the entire equipment in use at this point.

The steam section consists of four Babcock & Wilcox boilers, two of them being of 200 h.p. each, the remaining two being each 300 h.p. The conventional accompaniment of Worthington feed pumps, one Hooper exhaust heater, one Worthington condenser placed in the basement of the building, and outside under the sidewalk a cement tank with a capacity for 620 bbl. of oil.

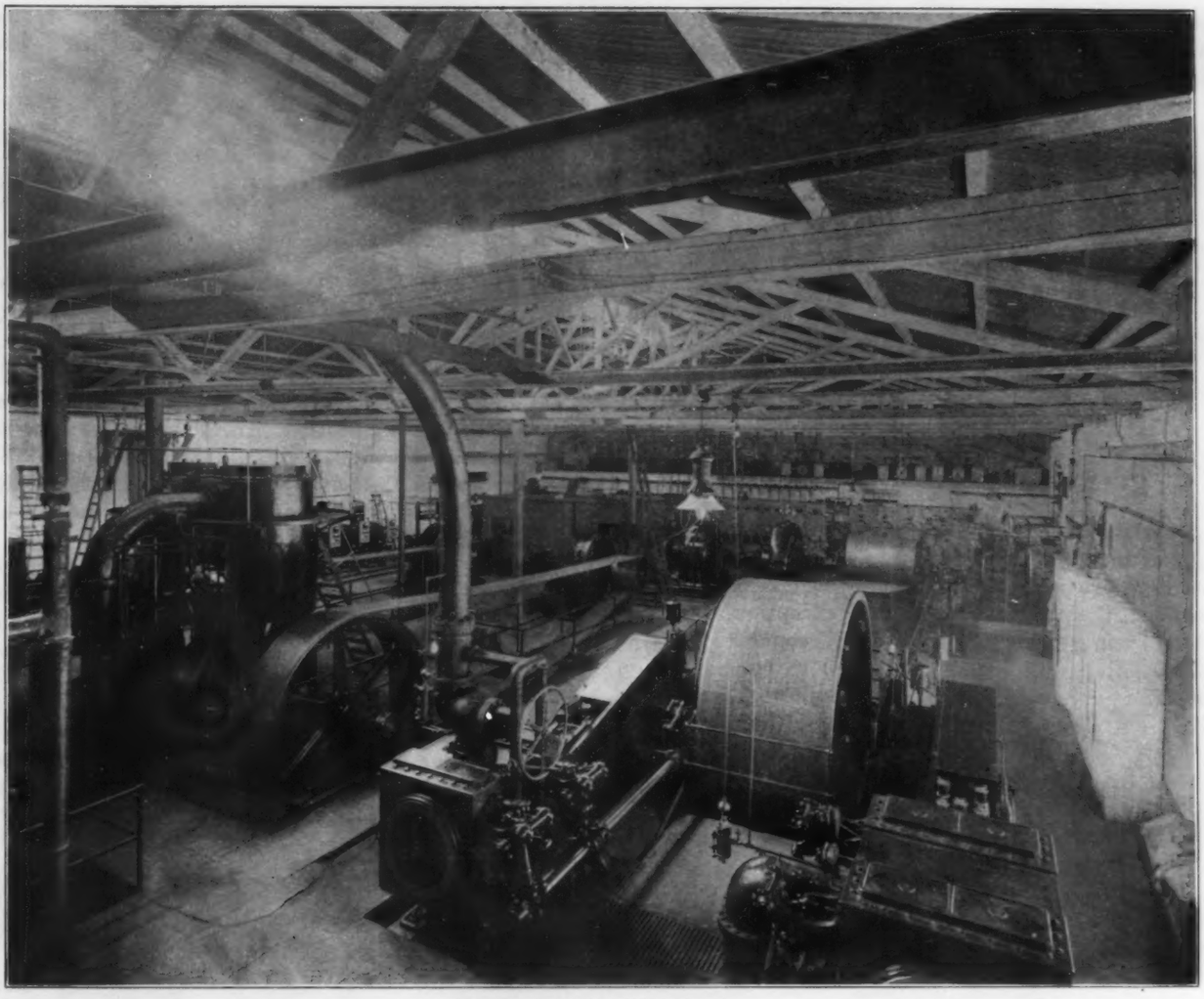
Held ready for immediate operation at all times is a cross compound grid. valve, MacIntosh and Seymour 750 h.p. engine. This engine is connected through a double 4 ft. belt to a pulley which forms a joint connection between two motor-generator sets. Thus, it is possible by manipulation of the clutches at either end of this pulley to drive the motor generators from the engine in case of failure of the supply of electricity from the transmission system. These motor generator sets consist on one side, of a Westinghouse 335 h.p.



Wiring Diagram San Joaquin No. 1 Power House.

It is proposed, in the near future to erect a low dam at the intake of this plant, enlarge the tunnel and pipe, sealing the junction between, thus carrying the pressure head from the reservoir level formed by the dam. A single 3,000 kw. generating unit is to be installed in a modern concrete fireproof structure.

synchronous motor on which is directly mounted a 6 kw. 6 pole exciter. This motor is connected through a flexible coupling to a General Electric 200 kw. 6 pole d.c. generator, the other end of the shaft being connected to the engine pulley through a jaw clutch operated by a hand wheel gear. Connected to the other



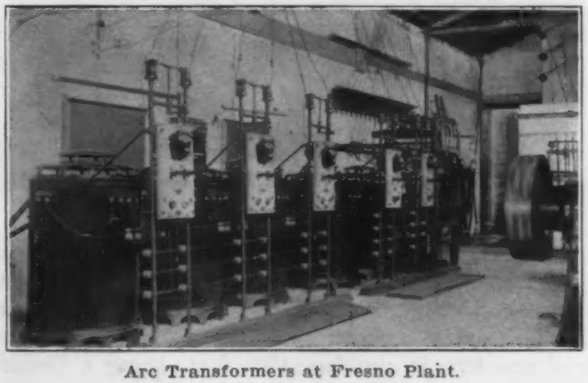
Interior Fresno Steam Plant.

end of the pulley through a similar jaw clutch is a motor generator set of a somewhat later type, having but two bearings. This set has a Westinghouse 200 h.p., 2,200 volt, synchronous motor. The generator is of the same make, of 200 kw. capacity. The exciter is mounted on the shaft as in the first instance. The speed of the set is 450 r.p.m.

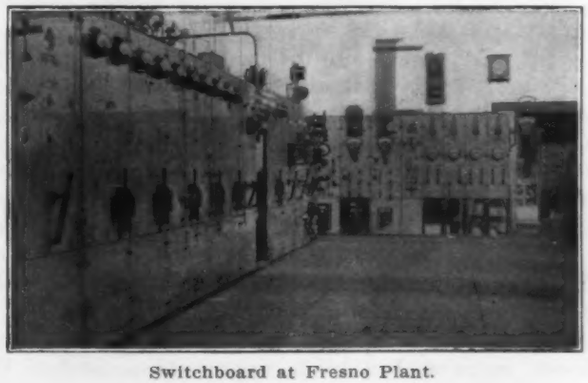
There has been recently installed an additional Westinghouse motor generator set, the motor being 580 h.p., operating at 720 r.p.m. The generator is 400 kw., equipped with interpoles and a ball thrust bearing. This set is ordinarily used to carry the local street railway load. There is, for this set, a motor generator and exciter unit, consisting of a Westinghouse 10 h.p. induction type, C.C.L. 220 volt motor, operating at 1,110 r.p.m. and driving a 6 kw. generator of the same make.

Ranged along one side of the building are five General Electric 50 light 6.6 amp. arc transformers for series arc circuits, together with their equipment of control panels.

The switch board is of blue Vermont marble consisting of 25 panels. These control the 3 outgoing 30,000 volt circuits, 2 of them supplying Selma and Reedley and Dinuba; the third, Hanford, Corcoran, and Coalinga. There are 8, 2,300 volt circuits for

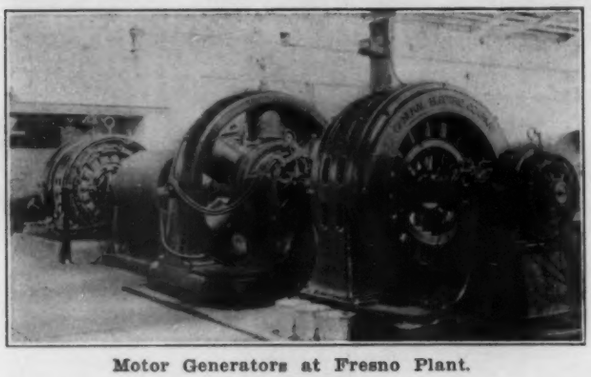


Arc Transformers at Fresno Plant.



Switchboard at Fresno Plant.

local distribution, and 3, 10,000 volt circuits for suburban distribution. The remainder of the panels control generators, motors, water works circuits and railroad circuits.



Motor Generators at Fresno Plant.

At the rear of the switch board placed in brick compartments which open only to the outside of the building, are four sets of Stanley water-cooled transformers, there being, with one exception, but two transformers to a set. They are T connected on the 30,000 volt side and are connected in open delta on the 2,300 volt side, and deliver both two and three phase current. The capacity of these transformers is 500 kw. There are in addition three General Electric air cooled transformers of 200 kw. capacity each. These are star connected on both primary and secondary sides and supply three phase current to the 10,000 volt suburban circuits.

The high tension switch gallery is a floor built over the transformer compartments and contains two lines of Kelman 30,000 volt oil circuit breakers, with a dividing wall between them, the entire gallery containing 15 sets of switches.

This station is the control point of the northern division of the system.

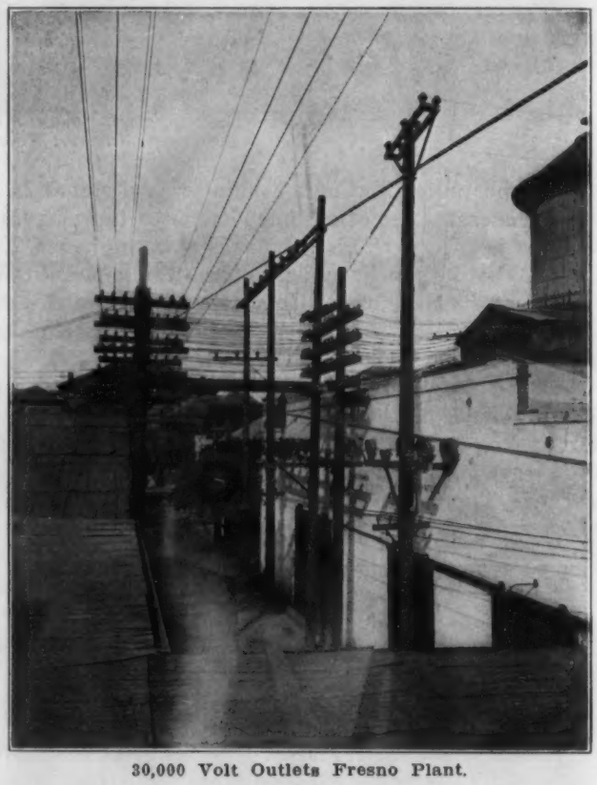
Bakersfield Steam Plant—This plant has but recently been placed in commission. It was built as an auxiliary emergency supply to the transmission system, and was placed at Bakersfield as the logical center of distribution for the Southern Division, and as the cheapest fuel depot. This plant is strictly modern throughout and represents the best practice for efficiency and stand-by service.

The building, like all the recent work of this company, is of massive steel frame construction covered with Hyrib expanded metal and finished with plaster concrete walls. It is in two main sections divided by a fireproof wall, one containing the boilers and fuel supply apparatus, the other the prime movers, auxiliaries, transformers, and the switching apparatus. The building is fireproof throughout. In the boiler section along either side are 4 boilers, both sides being similar and consisting of two Babcock & Wilcox boilers of 450 h.p. each, and two Sterling boilers of 500 h.p. each. Natural gas, piped from the near-by Kern River oil fields, is the fuel ordinarily used, although oil burning equipment is installed as a reserve. Fuel oil is drawn from the large steel tank placed in the yard near the power house.

The other section of the power house has three floors, more or less broken up to accommodate the apparatus contained thereon. The first, or ground floor, contains the engine and boiler auxiliaries,—two Harrisburg (Fleming) tandem compound engines direct connected to Byron Jackson circulating pumps, two Alberger dry vacuum pumps of size 10 x 18 x 18, three Worthington and one Epping-Carpenter feed pumps, and two Alberger surface condensers which are placed within the arch of the foundation under the main turbine generating units which are at the level of the second floor.

On either end of one side of this section are the two main transformer compartments. The first of these contains four (1 spare) General Electric 833 kw. water cooled transformers, whose primary voltage is 2,300. There are two secondary voltages of 10,000 and 66,000 with star connection. In the other transformer compartment are four Allis-Chalmers water-cooled transformers of the same voltage ratio as the others without the 10,000 volt windings. These have a capacity of 2.100 k.v.a. each.

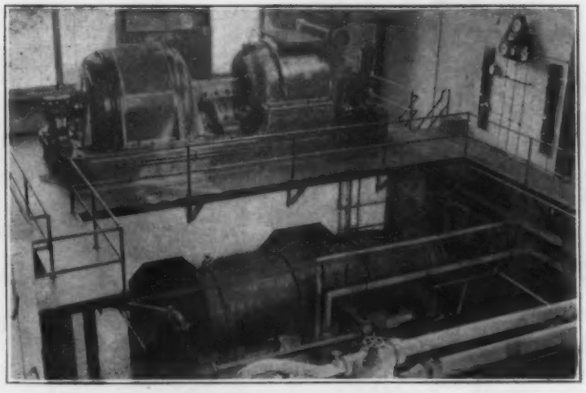
On the ground floor and arranged along the rear walls of the building between the transformers compartments are all of the 2,300 volt switch cells and switches. In this space are also two motor generator sets, consisting each of a General Electric type I 350 h.p., induction motor, direct connected with solid coupling to a 6 pole, interpole, 225 kw. d.c. generator. These machines supply current to the street railway system in Bakersfield and vicinity. There are also two General Electric motor generator exciter sets, the motor being of 60 h.p., 2,200 volts, induction type, the



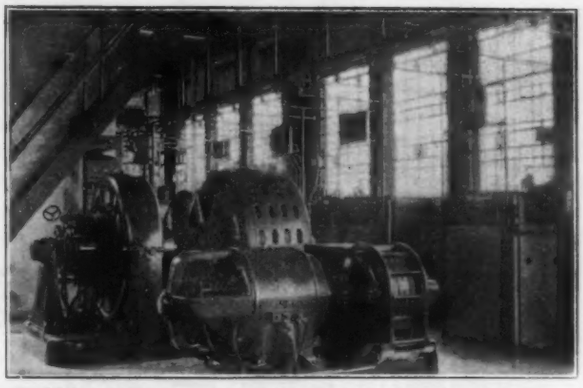
30,000 Volt Outlets Fresno Plant.

generator being of 50 kw. There is also one steam exciter set having a 75 kw. generator driven by a Curtis non-condensing turbine and operating at 3,300 r.p.m.

The main generating units on the second floor level are two in number, the first being a General



One of Turbo-Generators.



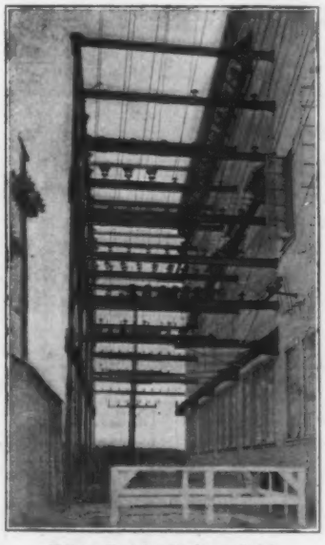
Motor Generators, Exciters and 2300 Volt Switches.

Electric horizontal set, having a capacity of 2,500 kw. and operating 1,200 r.p.m. The second unit, built by the Allis-Chalmers Co., has a capacity of 5,000 kw.

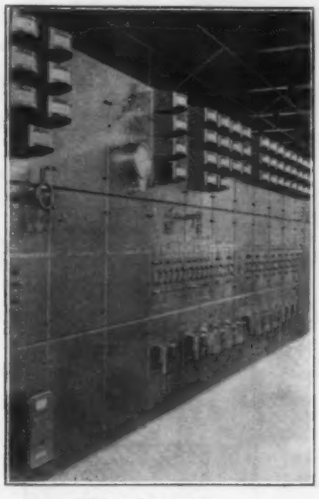
On the second floor gallery at its center is placed the main switch board. This was built by the General Electric Co., is of black slate, and consists of 23 panels. The panels are equipped in accordance with the most modern practice, with horizontal type instruments and remote control for all of the generating and outgoing circuits. On the iron pipe frame at the back of the switch board are mounted integrating and graphic recording wattmeters for each circuit.

Placed on the gallery at the rear of the switch board are all of the 10,000 volt General Electric oil circuit breakers, in such order as to cause the least possible confusion in the minds of the operators.

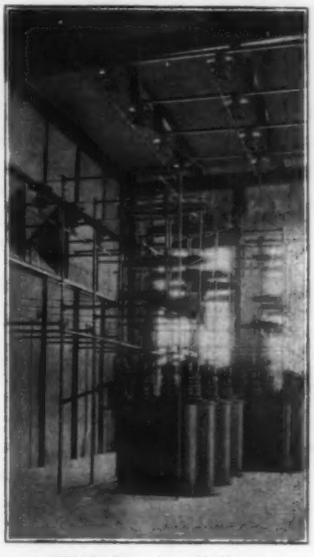
On the third floor or gallery are placed four sets of General Electric K-10 solenoid operated 60,000 volt oil circuit breakers. Two of these sets are on the two sets of transformers and two on the two outgoing transmission lines. The 60,000 volt leads of 1 in. cop-



Wire Rack, Bakersfield Steam Plant.

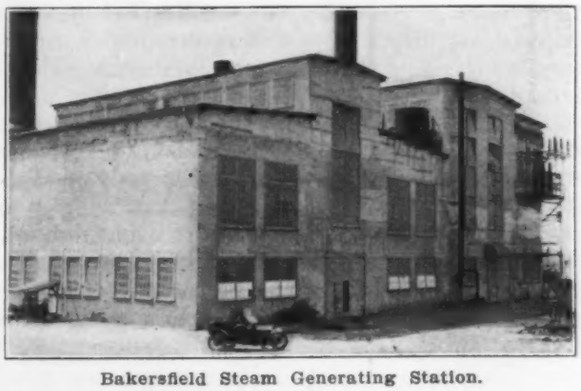


Main Switchboard.

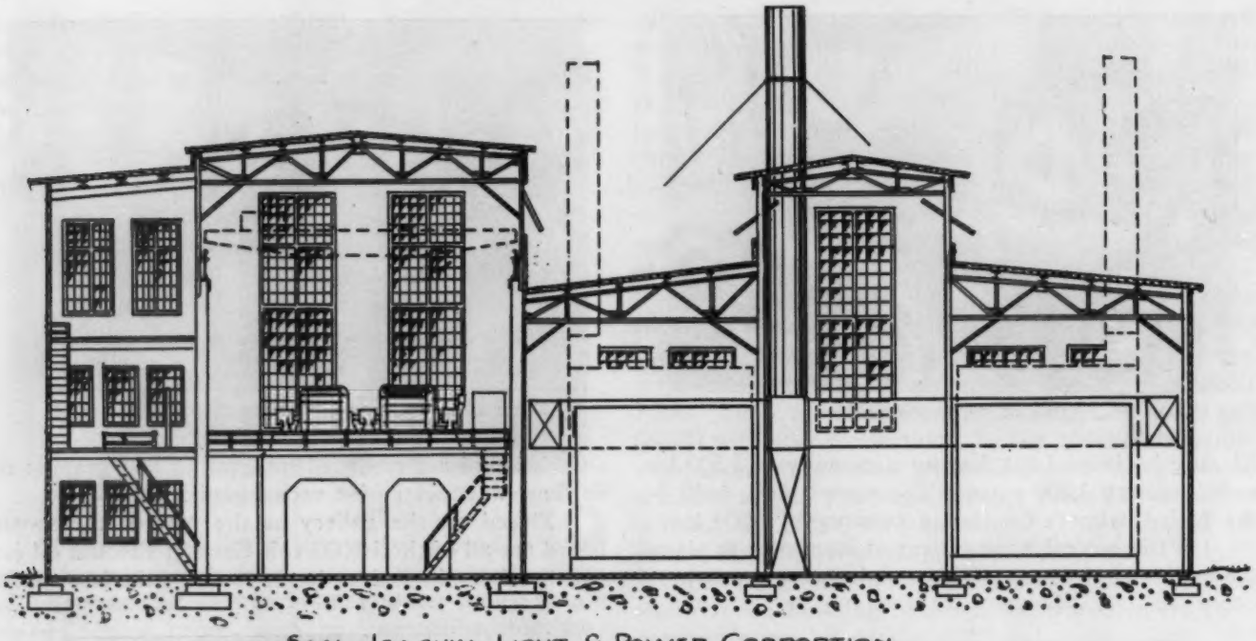


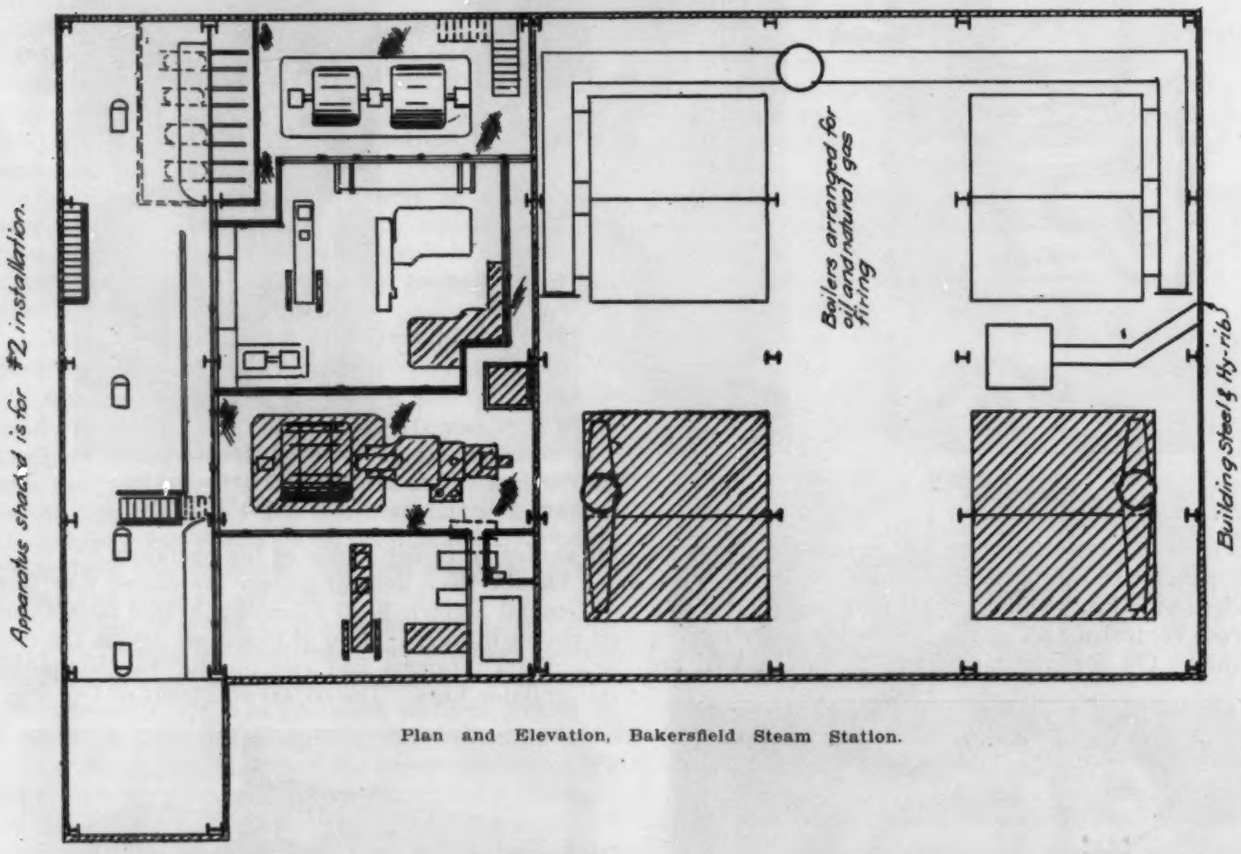
High Tension Gallery and Switches.

Looking Down at Steam Auxilliaries.



Bakersfield Steam Generating Station.





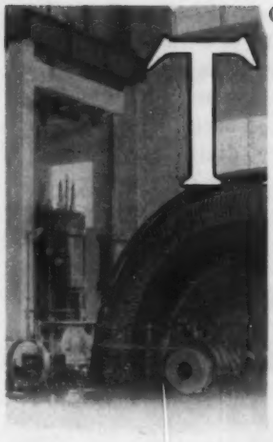
Plan and Elevation, Bakersfield Steam Station.

per tubing are brought up to the level of this floor through 3 ft. square ducts, and led directly to the oil circuit breakers. The connection between these and the outgoing line circuit breakers is made through a bus line and the customary intervening disconnecting switches. All of the high tension wiring is mounted on standard triple petticoat insulators on structural steel framework.

At the rear of the building is a structural steel rack which covers the entire side. This carries at their proper level all of the circuits which enter or leave the building.

Near the building and connected to the 60,000 volt outgoing circuits are General Electric aluminum cell lightning arresters, for though lightning is of rare occurrence, these are deemed a necessary precaution.

Substations.



TO maintain exact standards in the design of the various essential parts of any large transmission system is difficult, particularly in one of the magnitude and diversification in the distribution of this system. Especially is this true of the sub-stations, some of which have been in operation a number of years, and which were intended for smaller loads and more primitive transmission conditions than exist at present. Two new types, however, modern in every respect and providing for present and future needs, have been developed and are sufficiently characteristic as to deserve careful study as to its efficiency and comparatively low cost and safety.

In general the substations may be classed in three types. One contains transformers receiving three-phase current at a potential of 30,000 volts and delivering from their secondary windings a potential of 10,000 volts for feeder circuits covering a distribution territory of not greater than 16 miles from the station, these stations requiring no regular attendant. The other are of the newer order and receive three phase current from the main transmission lines at a potential of 60,000 volts and distribute to main 30,000 volt feeders or to district 10,000 volt feeders. These stations are constantly attended by an operator who lives close by. The third type is novel and, in fact, quite radical, there being no enclosing building.

In the towns and cities, where distribution voltages of 2,400 or 4,000 volts are maintained, the substations are generally in buildings acquired in the absorption of local companies, or in connection with

Stone Corral Substation.

other enterprises maintained by the company, as gas or water works.

Of the newer type of substation there are four. The first, known as the "Copper Mine Sub," is situated where the foothills meet the valley, 16 miles northeast of Fresno. This is on the direct line of transmission between the power plants and that city, but acts as a distributing hub for the entire system, from its more northerly source of power. Two entering transmission lines deliver their current directly from the No. 1 power house, these lines being constructed for an eventual operation at 60,000 volts. Distributing from this station is a single 60,000 volt line, the main "west side" transmission which connects the northern and southern divisions and operates through to Bakersfield, passing through the "west side" oil fields. There are four 30,000 volt feeders, one for the Merced, Madera, Mendota and Los Banos districts, two to the city of Fresno, and one skirting the foot-

Madera Substation and Pumping Plant.

hills to the south to the Santa Fe stone crusher on the Kings River and the intermediate country.

The station at Henrietta is midway on the west side line between Copper Mine Sub., and Bakersfield, just northwest of Lake Tulare. From this point diverge two 30,000 volt circuits, one going to Coalinga and one in the opposite direction to Lemoore. This, like the Copper Mine Sub., acts also as a switching station.

The stations at McKittrick and Taft in the Midway oil fields are identical in appearance and equipment, the former having two 10,000 volt local distribution circuits, the latter two 10,000 volt and 30,000 volt outgoing circuits.

A description of the substation at Henrietta will substantially cover the others.

This substation is a steel frame building 30 ft. wide and 60 ft. long. There are four Fink trusses of steel which carry steel I beam purlins. The walls are of Hyrib expanded metal in two layers, one on the outside and the other on the inside of the steel columns. On this reinforcement is placed cement plaster which gives an outside and inside solid concrete wall, each 1½ in. thick. The roof is of the same construction, being plastered on both sides of the Hyrib, but having on the upper side a layer of asbestos board. Under the eaves are openings for the free circulation of air and in the ridge of the roof are three large galvanized iron ventilators, all of these openings being covered with No. ½ in. mesh woven wire screen to keep out birds and large insects. High temperatures are experienced part of the year and the rapid circulation of air is essential, especially in view of the use of air cooled transformer cases.

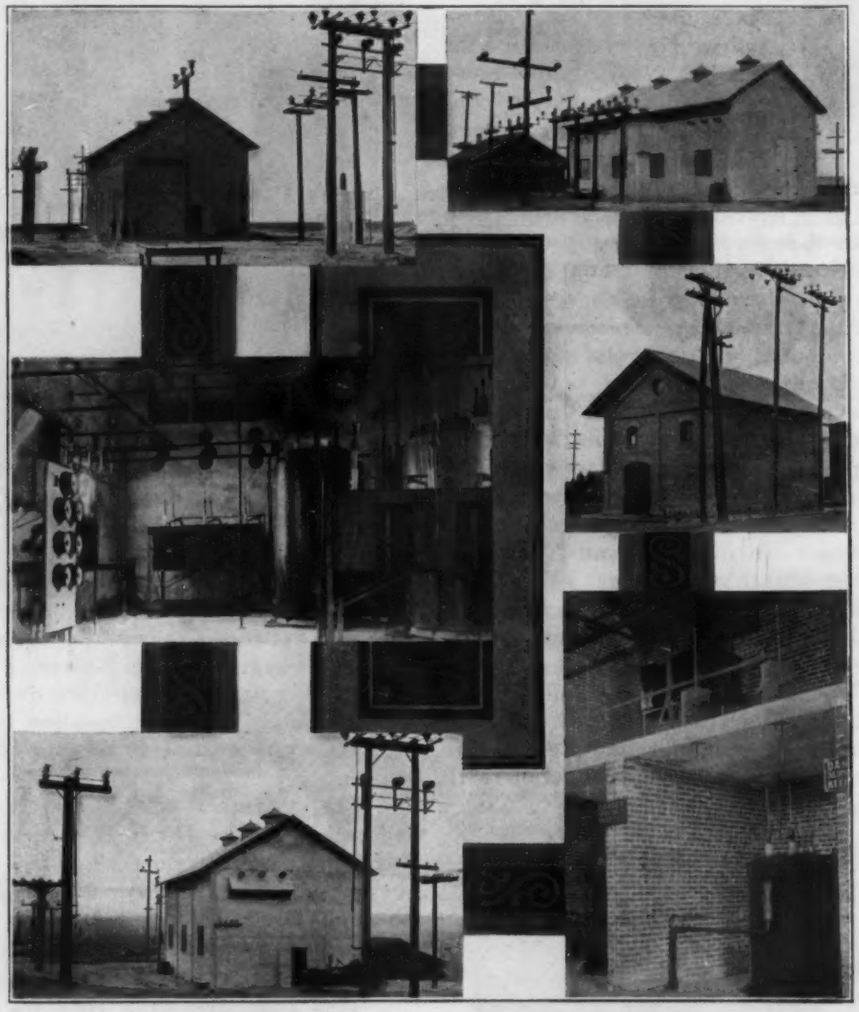
The 60,000 volt line is led into the building through the standard type of inclined wall bushing adopted by the company, through disconnecting switches mounted on standard insulators supported on an angle steel frame, to the Kelman circuit-breakers and thence to a bus line which extends the length of the building and which, passing through a switch equipment, similar to the one just described but reversed in order, to the continuation of the transmission.

Taps are taken from the bus line to feed the transformers, the current first passing through a disconnecting switch set and Kelman circuit-breakers, all mounted on a steel frame. The high tension wiring is all of 7/8 in. copper tube.

There are four Allis-Chalmers 500 k.v.a. lowering transformers. These have voltage ratios of 41,000/17,000, being Y connected on both sides for circuits of 60,000 and 30,000 volts respectively. In the stations having 10,000 volt distribution circuits the low tension windings deliver 6,600 volts which are Y connected for 10,000 volts 3-phase. The fourth transformer is a spare, in case one of the others fail from any cause. The transformer cores are immersed in oil in cast-iron tanks which carry an outer shell. This arrangement provides a space between the tank and shell which allows of a rapid convection of the air currents and a continuous supply of cool air from the floor to carry away the heat generated from within and conveyed to the case through the oil within.

The secondary lines are carried on insulators mounted on a steel structure to a secondary bus which supplies the various secondary distributing circuits, after passing through Kelman, three-pole single-throw oil circuit breakers. A single panel of Vermont marble contains three ammeters, a volt meter, integrating wattmeters for each outgoing circuit and a graphic recording voltmeter and in some cases a wattmeter of similar type. A complete telephone equipment with the various protective devices is included. Mounted on concrete bases, outside of the building, is a set of General Electric, outdoor type, aluminum cell lightning arresters and horn gaps, and mounted on the first pole structure from either end of the building are outdoor disconnecting switches.

The older type of station used on distributing lines is of corrugated iron on a wood frame. In most cases the buildings are 30 ft. long by 20 ft. wide. The 30,000 volt circuit is led through a gable end through



Henrietta Substation.
Taft Substation Interior.
Taft Substation Exterior.

Copper Mine Substation.
Fresno Water Substation Exterior.
Fresno Water Substation Interior.

openings 12 in. in diameter. Kelman 30,000 volt, overload release, hand operated circuit breakers are used. There are three and, in some cases, six lowering transformers; these being Wagner oil immersed and air cooled, the latter action being assisted by steel fins radiating from the sheet steel cases. These stations are all equipped with Wirts carbon resistance gap lightning arresters. The outgoing circuits are controlled by Kelman switches. There is no switch board, but integrating wattmeters are mounted on a steel framework close to the outgoing circuits. These substations require little attention, except for throwing switches and reading meters. There are seven of these substations as follows: Madera, Kings River (Santa Fe rock crusher), Kerman, Reedley, Stone Correl, Selma and Corcoran.

In the towns where substations contain a switch board for local city distribution and arc lighting circuits, the local conditions govern the installations, as in Merced, Lemoore, Fresno (already described under the heading of power plants) and Bakersfield.

The distribution system and substation at Coalinga are owned and operated by a separate corporation who purchase power on their own transmission line at Henrietta.

The local distribution for the city of Hanford is also owned by a separate corporation who buy power, delivered from a 30,000 volt circuit from this company at their own distributing station.

The substation at Merced is a steel frame concrete building, 30 ft. wide by 50 ft. long and adjoins the gas works. The roof is supported on five deep Howe steel trusses between the gables. This station contains three 150 kw. General Electric water cooled transformers wound for 11,000 volts primary on Y connection and 2,300 volts secondary for local city distribution. These are arranged along one side of the building and in line with them are two General Electric 50-light, a.c. arc transformers with their accompanying panel-boards. There is also a one-panel switch board on which is mounted two oil switches for city circuits. Behind this is a General Electric, 2,200 volt, 38 kw. potential regulator.

The remainder of the floor space is provided for four lines of three lowering transformers; at present but one set of three is installed. These transformers are similar to those described, having a capacity of 117.5 kw. each, being wound for Y connection voltages of 30,000 primary and 11,000 volts secondary. There are two outgoing 11,000 volt circuits. Kelman automatic overload release oil circuit-breakers are provided on all incoming and outgoing circuits.

One of the newest, most pleasing and efficient of the substations, sufficiently different from the others to deserve special mention, is that of the Fresno water company. The building is of brick, 27 ft. wide and 30 ft. long and equivalent to two ordinary stories in height. The roof is of concrete on Hyrib expanded metal with asbestos board covering and is supported on three Howe steel trusses, two of them being in the gables. There are three transformer compartments along one side, the barriers between the cells being of brick. The cells are closed on top by a mezzanine floor 4 in. thick of reinforced concrete and upon this floor are mounted two sets of Kelman automatic overload release oil circuit-breakers, one on each of the two incoming 30,000 volt lines. These circuit-breakers are connected through a bus line of 9/32 in. copper tubing, the bus in turn being divided by double break disconnecting switches. From the center of these switches are led the lines through openings in the mezzanine floor which feed the transformers. The transformers are Allis-Chalmers, 300 k.v.a, water cooled and are delta connected on the high tension side. The low tension sides deliver current at 2,300 volts. This substation is designed to be used eventually with 60,000 volts incoming lines and the transformers are wound so that they may be star connected for this potential. The switch board, or rather steel switch rack, extends the length of the building parallel to the other side. On this are mounted General Electric 3-pole oil switches and above them disconnecting switches. An ammeter is mounted on the rack for each circuit. There are eight outgoing circuits, with space for three additional; each circuit is carried through conduit under the floor out of the building, to and up the first pole, each eventually being carried to one of the eight individual pumping plants.

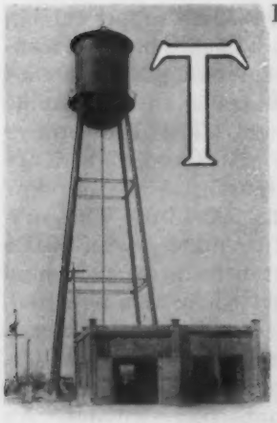
At the Los Banos and Mendota are two "outdoor" type substations. All apparatus except the instruments are arranged for open air operation. The high tension Kelman switches are mounted on steel frames and have a weatherproof covering. The 60,000 volt connections and transformer bushings are of a weatherproof type. A small house, large enough for the instruments and telephone, is situated somewhat away from the main apparatus. There is no regular attendant, and it is calculated that the chance of losing a transformer in the absence of an attendant does not equal the interest on the added investment of a fireproof building and the wages of a man. This type of installation is in great favor with this company.

Following is the location and equipment of all of the substations:

	Instld	Pr	Instld	Pr	Instld	Pr	Instld	
Power House No. 3, Snelling	...	53	...	...	...	...	...	
Merced (Snelling)	...	...	...	...	44	...	...	
Merced District	...	...	...	...	39	7	6	
Merced to Madera	...	...	30	...	42	...	...	
Madera to Los Banos	...	...	75a	...	...	...	...	
Madera to Mendota	...	...	...	...	...	...	...	
Los Banos District	...	...	...	...	29	...	...	
Mendota District	...	...	...	...	17	...	...	
Madera District	...	...	...	...	30	...	...	
Copper Mine Sub., Madera	...	...	30b	...	...	...	...	
Copper Mine Sub., Friant	...	...	...	...	13	...	...	
Crane Valley, P. H. 3	...	...	...	...	5	...	...	
P. H. 3, P. H. 1	...	...	11	...	13	...	...	
P. H. 1, Big Creek	...	...	24	...	3	...	...	
P. H. 1, Copper Mine Sub	...	...	49a	...	...	...	...	
Copper Mine Sub., Tulare Sub.	...	...	82a	...	21	...	...	
East Side line (Prop)	...	120	...	...	...	...	...	
Reedley Sub.	...	...	...	...	48	...	19	
Stone Correl Sub	...	...	...	...	38	...	...	
Tule P. H., Camp	...	...	...	...	9	...	...	
Copper Mine, Fresno	...	...	31	...	...	...	...	
Fresno, Kerman	...	...	17	...	...	...	3	
Fresno, Stone Correl & Reedley	...	...	53	...	...	...	...	
Fresno, Stoil	...	...	68	...	...	...	...	
Fresno District	...	...	...	...	45	...	20	est.
Selma District	...	...	...	...	...	...	27	
Carruthers, Raisin City	...	...	...	...	...	15	...	
Hanford, Henrietta	...	...	20	...	...	...	4	
Corcoran District	...	...	...	...	30	...	...	
Stoil District	...	...	...	...	35	...	...	
Copper Mine Sub., Bakersfield	208	...	...	...	...	...	...	
McKittrick, Midway	...	...	...	...	58	...	...	
Bakersfield, Famoso	24	...	...	...	100	14	...	
Bakersfield, Edison, P. H.	...	...	...	...	84	...	6	
Bakersfield City District	...	...	...	...	...	...	20	est.
Total, S. J. L. & P. lines	232	173	490	...	703	36	105	
Coalings, L. & P. Co			28		38			
Additional lines to supply substations at Stone Canyon, Paso Robles, San Luis Obispo, Santa Maria		150				122		
	232	323	518		741	158	105	

Total mileage of all lines operating and building, 2,077.
"a," Lines built for 60 kv. operation, but now operating at 30 kv.
"b," Lines operating at 30 kv., but soon to be rebuilt to operate at 60 kv.

Water Works Systems.



Kingsburg Water Works.

THE company owns or operates the water works in Fresno, Madera, Selma, Kingsburg, and supplies power for the operation of water works pumps at Bakersfield.

In all of these places the water is pumped from wells by motor driven centrifugal pumps into elevated tanks and also direct into the distributing mains.

The most important of these systems is for Fresno. This system is operated by a separate company owned by interests closely identified with the power corporation. There are nine wells scattered about the city, with one more about to be equipped. At each well is a substantial building, enclosing a concrete lined pit whose floors are on an average of 6 ft. below the ground surface. An 8 in. centrifugal pump, direct connected to an induction motor of from 50 h.p. to 700 h.p., completes the equipment. These pumps deliver directly into the city piping system against a pressure of 50 lb. Separate 2400 volt circuits are carried from the substation at the eastern edge of the city to the pumps, but a connection is also made from the main substation in the city to assure an unfailing supply of power. The substation at the city limits is connected to both incoming transmission lines and was placed at this point on advice of the Fire Underwriters to insure the first call on the transmission lines in case of damage to the lines within the city.

The company owns or operates the water works in Fresno, Madera, Selma, Kingsburg, and supplies power for the operation of water works pumps at Bakersfield.

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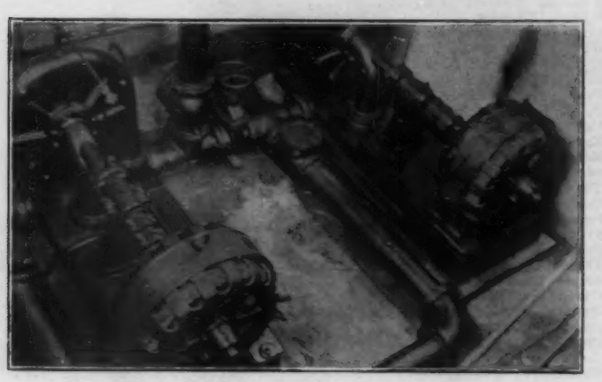
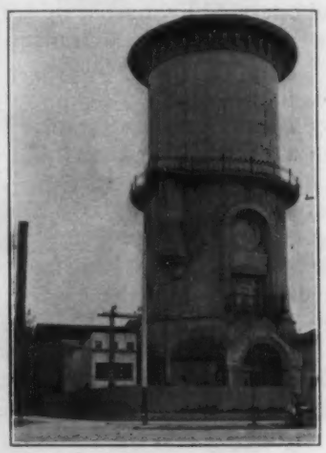


Pumps at Madera Water Works.

The most important of these systems is for Fresno. This system is operated by a separate company owned by interests closely identified with the power corporation. There are nine wells scattered about the city, with one more about to be equipped. At each well is a substantial building, enclosing a concrete lined pit whose floors are on an average of 6 ft. below the ground surface. An 8 in. centrifugal pump, direct connected to an induction motor of from 50 h.p. to 700 h.p., completes the equipment. These pumps deliver directly into the city piping system against a pressure of 50 lb. Separate 2,400 volt circuits are carried from the substation at the eastern edge of the city tc the pumps, but a connection is also made from the main substation in the city to assure an unfailing supply of power. The substation at the city limits is connected to both incoming transmission lines and was placed at this point on advice of the Fire Underwriters to insure the first call on the transmission lines in case of damage to the lines within the city.

A water tower containing a 250,000 gal. elevated tank operates as a stand pipe and will supply water for the city's uses for a period of 20 minutes in case of complete interruption of the supply.

Water for the Madera system is pumped from two wells situated near the substation. A brick building



Water Tower at Fresno.

with the walls carried down to a point 12 ft. below the ground surface encloses two pumping units. The units consist of Krogh No. 7 centrifugal pumps direct connected and driven by Westinghouse, 75 h.p., 440 volt and 1,120 r.p.m. induction motors. Water is pumped directly into the pipe system and there is a wooden elevated tank of 50,000 gal. capacity which acts in connection with the system.

The water works at Selma is enclosed within the substation building. Pumping is done from two wells 180 ft. deep by two pumping units. These are placed on a level, 10 ft below the ground surface. These units are No. 6, 8 in. pumps, direct driven by General Electric, 3 phase, 35 h.p. induction motors. Connection is made between the wells, pumps and the main through a series of four check valves and two gate valves, so that either pump alone will maintain a pressure of 35 lb. on the system, which is the ordinary mode of operation for winter service; or the two pumps in multiple delivering water under the same pressure; or, by changing the position of the gate valves, the pumps will be put in series and deliver a pressure of 70 lb. which is used in the case of a fire. There is a steam pump auxiliary in a separate building near the gas

works having its own well and a second motor pump auxiliary drawing from the same well.

The water works at Kingsburg are enclosed in a concrete building which also is used for a fire department house.

Gas Works.

The company owns and operates the gas works and distribution in Merced, Selma and Bakersfield.

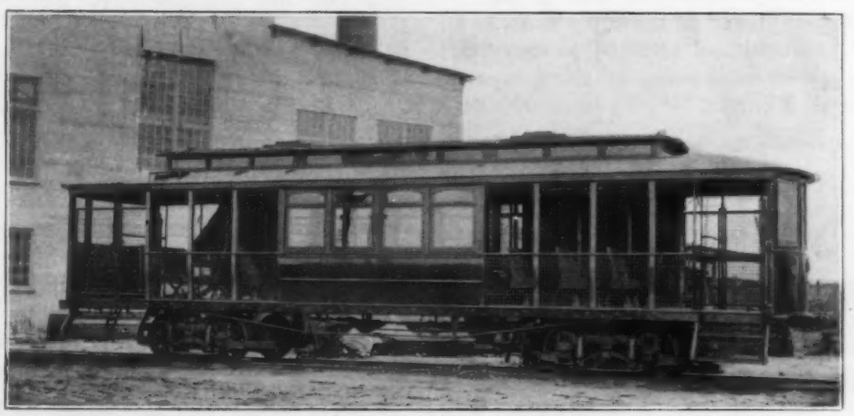
In Merced, as already stated, the gas works adjoins the substation. The plant was purchased from a local company and since its acquisition many necessary improvements have been made to bring it to its present state of efficiency. The gas making equipment consists of two "straight-shot" generators, each having a capacity of 7,500 cu. ft. per hour, one engine blower, one blower driven by a 10 h.p. induction motor and two 100 h.p. return tubular boilers. There is one 30,000 cu. ft. gas holder.

At Selma the gas works is enclosed in a corrugated iron building. The equipment consists of one "straight-shot" generator having an output of 5,000 cu. ft. per hour, one Western generator of 6,000 cu. ft. capacity, two 80 h.p. return tubular boilers, one 30,000 cu. ft. storage gas holder and one 10,000 cu. ft. relief holder. At a suitable distance from the building is placed a 500 bbl. steel oil storage tank.

At Bakersfield natural gas is used exclusively, although there is a plant, similar to those described, for making gas, which can be placed in operation on short notice.

Selma Gas Works.

Merced Gasworks and Substation.



New P. A. Y. E. Car at Bakersfield.

Street Railway System.

The only street railway system owned and operated by the company is in Bakersfield. This system has been in existence for a number of years and has been operated on a small scale by a former company. After the purchase by the present company the system was entirely remodeled and has been extended in a number of directions. Bakersfield has had a remarkable growth since the advent of the adjoining oil fields and is a city of good prospects. The wisdom of re-equipping the existing lines of the railroad will un-

doubtedly be manifest in the near future, because the possibilities of suburban extension in all directions are evident. As operated, the present system has 9.92 miles of line, including six miles of double-track. New Trilby 114 lb. rails have been laid and new trolley supports and connections make the equipment modern in every respect.

There are at present in regular use nine cars, three of these being reconstructed from the older equipment. The remaining six are of the latest California P.A.Y.E. type. They were built by the American Car Company at St. Louis. They are equipped as follows:

Trucks—Brill No. 27 G. E. I.
Motor—2 G. E. No. 203.
Gear—15.88.
Controller—G. E. K. 36 G.
Air Compressor—G. E. Type C. E.-27.
Air Valves—Style S, Form F.
Headlight—Crouse-Hinds Imperial luminous arc with lens.
Trolley Catcher—Ideal.

The cars of the company are handsomely finished in a light orange color with black trimmings and add greatly to the general street appearance of the city. Power is delivered to the trolley wire directly from the steam power plant of the company.

Management and Operation.

The company is operated in two divisions, the headquarters of the Northern being at Fresno where is also the main office for the system. The Southern division is managed from Bakersfield. The main divisions are divided into districts and each of these is presided over by a district agent. It is now proposed, due to the extensiveness of the system, to give the district agents practically complete jurisdiction of their several districts, attending to all of the business of the district, maintaining their own office accounts and, as far as possible, relieve the main offices of all detail. A high class of men are employed in these positions, who have been carefully trained and selected to carry out the liberal and straightforward policy of the company.

The districts are as follows:

Northern Division.

Merced—Merced County east of San Joaquin River, all of Mariposa County.

Madera—Madera County, except generating plants and canals.

West Side—Los Banos, Gustine, Dos Palos, Mendota, Firebaugh.

Fresno—San Joaquin generating plants and canals, Fresno City, Clovis, Sanger, Malaga, Calway, Kerman, Friant, Piedra, Big Creek.

Selma—Kingsburg, Layton, Selma, Fowler.

East Side—Dinuba, Reedley, Parlier, Wahtoke, Sultana, Orosi, Stone Corral, Woodlake.

Corcoran—Corcoran, Waukena, Stoll, Angiola, Alpaugh, Lemoore, Hanford.

Southern Division.

Bakersfield—Bakersfield, Famoso, Wasco, McFarland, Pond, Edison, Lerdo, Kern River oil fields.

Midway—Maricopa, Sunset, Taft, Fellows, McKittrick.

Coalinga—Coalinga, Bradley, San Miguel, Paso Robles, Templeton, Santa Margarita, San Luis Obispo, Pismao, Arroyo Grande, Santa Maria, San Lucas, San Ardo, Kings City.

It is the policy of the company to maintain close friendly relations between the heads of departments and the men in all positions, and the latter are taught to maintain by every means possible the very liberal policy which the company has adopted in its attitude to the people at large. In this connection the company has always maintained that they were able and willing to show their good faith and desire to give the greatest satisfaction and maintain the best service and have made it a rule to build lines into a new country having possibilities for business where it might have been difficult to get the business first, but by so doing gaining the confidence and good faith of prospective customers. The good results of this policy are strongly evident on every part of the system. Disputes or grievances are given the closest attention without regard to the reasonableness or difficulty in reaching the party in question and are not dropped until thorough satisfaction is administered. In the transmission line maintenance there is one hard and fast rule—no lineman is permitted to work upon a live circuit or upon a circuit where there is another live circuit on the same pole.

The record for service, which might be expected from an organization as well systematized as this, has been good, notwithstanding the many recent changes in adopting the newer standards, and throughout the system is well worth the time necessary by the transmission engineer to study the many unique and characteristic features, the result of a development to fit the very special conditions of the territory involved.

ELECTRICITY IN MINING.

As part of its mine-accidents investigations, the U. S. Bureau of Mines is studying the problem of safeguarding life and property from the dangers that attend the use of electricity underground. One of its inquiries has to do with the removing of a possible cause of mine explosions through the use of explosion-proof motors—that is, motors with covers for those parts that emit sparks. Another investigation has to do with the determination of the most efficient and safest types of insulation for use about mines and metallurgical plants in order to protect miners and other employees from shock. Still another line of investigation relates to the possibility of igniting explosive gases through the breaking of incandescent electric lamps in the presence of such gases. Other investigations relate to the electric firing of shots and to other uses of electricity in mining operations. The preliminary recommendations of the bureau in regard to regulations concerning the use of electricity in mines have been generally accepted by mining engineers and have been incorporated in the mining law of the largest mining State.

REPORT ON STATE GAS LAWS.

The National Bureau of Standards have issued a report of all laws in the various States relating to the manufacture and testing of illuminating gas, its distribution, candlepower, heating value, purity and pressure and the testing of gas meters.

WESTERN LAWS OF ELECTRICITY AND WATER

WATER RIGHT LEGISLATION. (In California, Colorado and Wyoming)

BY A. E. CHANDLER.

Legislation regarding water rights to be complete must provide for the acquirement of rights, for the definition or adjudication of existing rights and for the distribution of water among those entitled to its use.

California.

With the reception of the Statutes of 1911, dealing with the appropriation of water for power purposes only, Sections 1410 to 1422 of the Civil Code contain all of California's legislation in regard to the acquisition of water rights.

As previously stated these sections simply provide for the initiation of rights by the posting of notices and for the benefits of the doctrine of relation if the works are completed with reasonable diligence. There is no provision for public inspection at any stage.

There are no statutes specially providing for the adjudication of water rights, and disputes between ditch owners are subject to the regular court procedure. The litigation is, therefore, between two or more claimants, and rarely are all the appropriators brought into a single action. Where there are many diversions, as is the case on the ordinary stream, there may be an indefinite number of actions without all the rights on the stream being adjudicated.

Likewise, there are no statutes providing for the distribution of water according to decree. Ordinarily the successful contestant has to resort to either force or contempt proceedings in order to obtain what the court has given him, and the former is too frequently the choice.

Colorado.

Acquirement of Rights.—The first statutes regarding water rights adopted in the various western states were patterned after those of California. The first state to make any advance was Colorado where the office of state engineer was established in 1881.

At the same session the so-called "Map and Statement" act was adopted but, owing to a defective title, was held unconstitutional in 1899. A second act, very similar to the first, was passed in 1903, and now governs the acquirement of rights. It provides that within sixty days after the commencement of the surveys or of the actual construction of any ditch or reservoir or enlargement or extension thereof, a filing must be made in the office of the state engineer of duplicate maps and statements containing the information required by the act and of a form satisfactory to the state engineer. If satisfactory to the state engineer one copy is filed in his office and the other approved and certified and returned to the claimant who must, within 90 days from date of commencement, file it in the office of the county clerk of county in which the headgate or reservoir lies. It is further provided that a certified copy of the map and statement shall be prima facie evidence of the intent of the claimant. The Act of 1881 provided that the right dated back to the commencement of the work upon compliance with the act and the exercise of reasonable diligence in construction. The present act is silent on this important point but where all the prescribed steps are taken the courts will undoubtedly hold that the right dates from the commencement of the work.

The state engineer has issued a circular containing the list of fees (Act of 1911), text of forms, and the rules and regulations in regard to the preparation of maps and statements. The circular states, "It is compulsory to use the forms of statements and affidavits as given herein. It will save time and delays." There is no question, therefore, but that the state engineer has a satisfactory record of the intention of new appropriators in Colorado, but there his supervision ends. Other than the provision that due diligence in construction must be exercised, the act is silent regarding any record of proof thereof, so that the claimant, in case of dispute, must settle the point in the courts, as in California. In regard to the acquirement of rights, therefore, Colorado has but slightly improved upon California.

Adjudication of Rights.—Colorado in 1879 and 1881 adopted a special procedure for the adjudication of water rights. It was provided that on or before June 1, 1881, every claimant of an interest in a ditch or reservoir within any water district should file with the clerk of the district court having jurisdiction a sworn statement setting forth among other things the date of his appropriation by original construction, also by enlargement or extension, the amount of water claimed, the existing capacity of ditch and the number of acres lying under and being or proposed to be irrigated by each ditch or reservoir. Since the date for filing such claims, June 1, 1881, an adjudication of all rights to water from a common source within a district is initiated by one or more interested persons (who have filled the required claim) petitioning the district court having jurisdiction. The judge either sets a day for the taking of evidence in open court or, as is the usual practice, appoints a referee to take and report the evidence, make an abstract and findings upon same and prepare the decree. The referee gives notice of the times and places at which he will take the required evidence and proofs of priority. In regard to the facts to be ascertained by proofs the act provides:

> Said referee shall also examine all witnesses to his own satisfaction, touching any point involved in the matter in question, and shall ascertain as far as possible the date of the commencement of each ditch, canal or reservoir, with the original size and carrying capacity thereof, the time of the commencement of each enlargement thereof, with the increased carrying capacity thereby occasioned, the length of time spent in such construction or enlargement, the diligence with which the work was prosecuted, the nature of the work as to difficulty of construction, and all such other facts as may tend to show compliance with the law in acquiring the priority of right claimed for said ditch, canal or reservoir; and upon all the facts so obtained shall be determined the relative priorities among the several ditches, canals and reservoirs, the volume or amount of water lawfully appropriated by each as well as by means of the construction,

as to the enlargements thereof, and the time when each such several appropriations took place.

After closing the testimony the referee prepares the report and form of decree and files it with the court, which after properly ordered hearings either approves or modifies the same.

The act provides in detail for the many steps in the procedure and is sound from the technically legal standpoint. Its weakest point is that it does not provide for representation of the public or the state. Many of the older decrees gave to each party the amount of water claimed, which was generally far in excess of the maximum capacity of the ditch. There should have been measurements by the state engineer of the ditches and the acreage irrigated, but he is not mentioned in the act. Furthermore, the districts with which the act deals do not always include an entire stream, so that the adjudication in such cases is but partial. Aside from the trouble caused by the excess decrees, the act is to be commended as providing at so early a period in the history of irrigation a special procedure whereby most of the rights were determined.

Distribution of Water.—By an act passed in 1879 Colorado divided its irrigated territory into a number of districts generally comprising a designated creek, or creeks, and tributaries. For each district there was provided a water commissioner to be appointed by the governor from persons recommended by the boards of county commissioners interested. The principal duty of the water commissioner is to divide the waters of a stream among the ditches according to the prior rights of each, and in so doing to wholly or partially shut the headgates of the later appropriators to satisfy the earlier rights. He is also authorized to shut off the supply from any ditch so that the water delivered will in his judgment not allow a wasteful or wrongful use. The changing or interference with any headgate adjusted by the water commissioner is a misdemeanor subject to a fine of $300, or an imprisonment of 60 days, or both, and the use of water so wrongfully taken through such a headgate is made prima facie evidence of the guilt of the user. The water commissioners are further empowered to arrest persons meddling with headgates or using water procured through such. The salary of the water commissioner is $5 per day and is paid by the counties served. He does not begin work until called on by two or more persons controlling ditches in his district, or by the division engineer. He may engage necessary assistants at $2.50 per day.

In 1887 Colorado was divided into four divisions along drainage lines with a division superintendent in charge of each division. In 1903 the number was changed to five and the title to division engineers, who are now appointed by the governor from a certified list prepared by the state engineer after an examination of applicants. The division engineers receive $125 per month when actually employed and traveling expenses not in excess of $500 per annum, and are paid by the state. The division engineers have general control over the water commissioners of the several districts within their divisions, and, under the general supervision of the state engineer, execute the laws relative to the distribution of water. They may make regulations to secure the fair apportionment of water in accordance with the rights of priority. They are required to make stream measurements and rate ditches, and to perform such other duties as the state engineer may direct. Ditch owners feeling themselves injured may appeal from the acts of water commissioner to division engineer and from the latter to the state engineer.

It will be readily appreciated that the task of dividing water among ditches with valuable crops at stake is a serious undertaking, and on account of the daily variations in the flow of mountain streams requires much local study and experience. Colorado's plan of having a small number of great divisions along drainage lines each with a state official having jurisdiction therein, and a number of districts within each division of such size that the diversions may be regulated by one man and an assistant or two, was not only the first to be fixed by statute but remains the type to be followed at the present day.

Wyoming.

Acquirement of Rights.—The office of territorial engineer in Wyoming was created in 1886 but the existing legislation of which the state is so proud, came with statehood in 1890. By constitutional provision the state is divided into four divisions (the limits being fixed by the legislature) with a division superintendent at the head of each, the office of state engineer is provided, and a Board of Control consisting of the state engineer, as president, and the four division superintendents, is given "supervision of the waters of the State, and of their appropriation, distribution and diversion" subject to legislation thereon.

The statutes adopted in 1890 provide a method of acquiring rights very different from any then existing in this country. Instead of posting a notice or starting work and thus initiating a right, the intending appropriator is required to make application to the state engineer for permission to make the appropriation. The application is made on a blank form furnished by the state engineer and among other things must state the location and description of the proposed ditch, the time within which it is proposed to begin construction, the time required for completion of construction and the time required for complete application of water to proposed use. If for irrigation, the application must also give the legal subdivisions of land proposed to be irrigated. The state engineer must approve all applications made in proper form and for beneficial purposes except where there is no unappropriated water, or where the proposed use conflicts with existing rights, or threatens to prove detrimental to the public interest—in which cases he must reject the application.

If approved, the application will be so endorsed and returned to the applicant and constitutes his authorization to begin construction and perfect the appropriation.

In cases of applications in excess of 25 second feet, or to reclaim over 1000 acres, the state engineer, before acting on the application, may require additional information in regard to the financial ability and the good faith of the applicant. In the endorsement of

approval on the application it is required that actual construction must begin within one year from date of approval and that the construction must be completed within five years. The state engineer has authority to limit the construction period and the period required for application to beneficial use to a less time than asked for, and also, for good cause shown, to extend the time for the completion of works under an issued permit. Any party may appeal from any action taken by the state engineer to the Board of Control, and from an action by the Board to the digtrict court.

Applications must be accompanied by maps preparced in accordance with the regulations of the state engineer, and profiles and plans may be required also.

The statutes do not provide the nature of the proof to be submitted by the appropriator on the completion of the works and on the complete application to beneficial use other than it "being made to appear to the satisfaction of the Board of Control that any application has been perfected in accordance with such application, and the endorsement thereon." On such a showing the Board must issue a certificate setting forth the amount of the appropriation and the number and date of priority thereof, which date shall be that of filing the application in the office of the state engineer.

In 1903 a statute specially providing for the appropriation of water for storage in reservoirs was adopted. The steps outlined above must be followed except that a description of the land is to be irrigated by the stored water is not required in the primary, or first, permit. Those who are to apply the water to beneficial use may secure the secondary permit allowing them to so do. The latter shall not be given until the state engineer is convinced that the secondary permittee has a sufficient agreement with the owner of the reservoir, the primary permittee. The 1903 statute also provides for special supervision by a water commissioner when such stored waters are allowed to run to points of use through natural channels and where loss through wrongful diversion is probable en route. When deemed necessary for the protection of the various interests involved, the state engineer may appoint an assistant engineer to superintend and direct the construction work on dams for such reservoirs.

Wyoming has thus introduced a sensible business-like procedure for controlling new rights to the use of water. Those accustomed to the absolute want of supervision in states still following the California method of posting notices are inclined to be suspicious of the Wyoming method when first brought before them. They are especially fearful of the seeming great authority in the hands of the state engineer. An inspection of the records, however, will show so few applications rejected in Wyoming that the number is negligible. As the question of whether there are any unappropriated waters in a stream is so debatable and as the opportunity for flood waters and seepage and return waters is so great, the state engineer, in cases where there seems to be but little surplus approves the application with the following notice stamped upon it:

> The records of the state engineer's office show the waters of ..... to be largely appropriated. The appropriator under this permit is hereby notified of this fact and that the issuance of this permit grants the right to divert and use the surplus or waste water of the stream and confers no rights which will interfere with or impair the use of water by prior appropriators.

Definition of Rights.—Although new to American legislation the Wyoming method for the acquirement of rights is far less novel than her method for the definition of rights. In 1886 Wyoming, then a territory, adopted the Colorado system of adjudication but rejected it in 1891 for its present system.

Instead of leaving the determination of water rights to chance cases between two or more claimants as in California, or to a special procedure initiated by a claimant as in Colorado, Wyoming, having by its constitution declared the natural waters to be the property of the state, decided to make its new Board of Control responsible for this most important matter.

The Board selects the streams on which rights are to be determined and fixes a time for the taking of testimony. The state engineer through assistants makes a survey of the ditches and the land irrigated or irrigable thereunder and measures the stream and carrying capacity of the ditches. A printed form, called "proof of appropriation," is sent to each claimant. The present practice is to have the division superintendent make the survey and have the claimant make the "proof of appropriation" on the completion of the survey of his individual holding, so that the "proofs" and survey will correspond.

On the completion of the survey and the taking of testimony or "proofs" by the division superintendent, notice is given of a time and place at which the evidence thus assembled shall be open to inspection of the various claimants. A regular procedure is provided for contests and hearings before the division superintendent, if such are required after the open inspection.

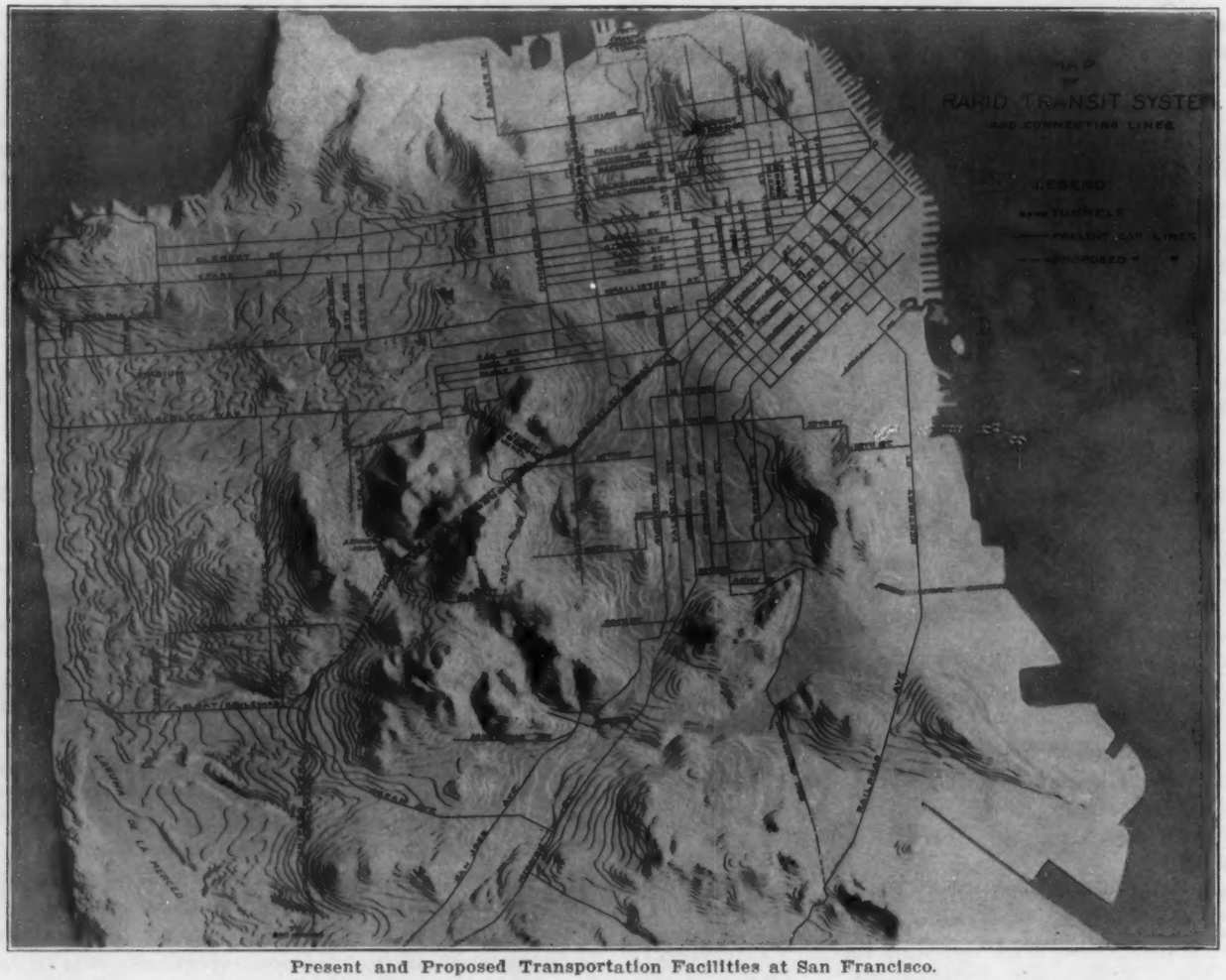
After the contests all the evidence, including original proofs and testimony taken at the subsequent hearings, is transmitted to the Board of Control. At its first regular meeting thereafter, the Board examines all the evidence and enters an order establishing the priorities of the water rights, their amounts, and the character of use of each. For irrigation rights, the maximum allowance is one-seventieth of a second foot to the acre. Certificates are issued to each claimant in accordance with the order of the Board. Appeals from the order may be taken to the district court within sixty days.

Distribution of Water.—As stated above, Wyoming has been divided into four divisions along drainage lines. The superintendents thereof have powers similar to those of the division engineers in Colorado, regarding the division of the waters among ditches entitled thereto. The Board of Control creates districts where necessary and these districts are in charge of water commissioners upon whom the actual duty of closing headgates rests. The entire Wyoming procedure in regard to this matter is copied from that of Colorado and what difference exists is only in minor details.

THE ARNOLD REPORT ON THE SAN FRANCISCO TRANSPORTATION PROBLEM.

Five preliminary reports have been made to the San Francisco Board of Supervisors by Bion J. Arnold on the transportation problem of that city. These first reports are chiefly concerned with the two matters of greatest present popular interest, ways and means of adequate transit to the site of the Panama-Pacific Exposition and the Twin Peaks tunnel. Each report carries several alternative plans with full discussion of the advantages thereof.

Of the various plans which have been presented with regard to the Twin Peaks tunnel the report favors either a low-level trolley bore as a direct extension of Market street from Valencia street to the San Miguel tract near the junction of Corbett Road and Dewey Boulevard, or preferably a curved extension of Market street to Eureka street, (following the natural contours around the northern slopes of Eureka Valley) whence a tunnel can be driven to San Miguel Rancho, emerging near T street and Dewey Boulevard with sub-grade passenger transfer station at Seventh avenue Boulevard east of Lake Honda and surface car



Present and Proposed Transportation Facilities at San Francisco.

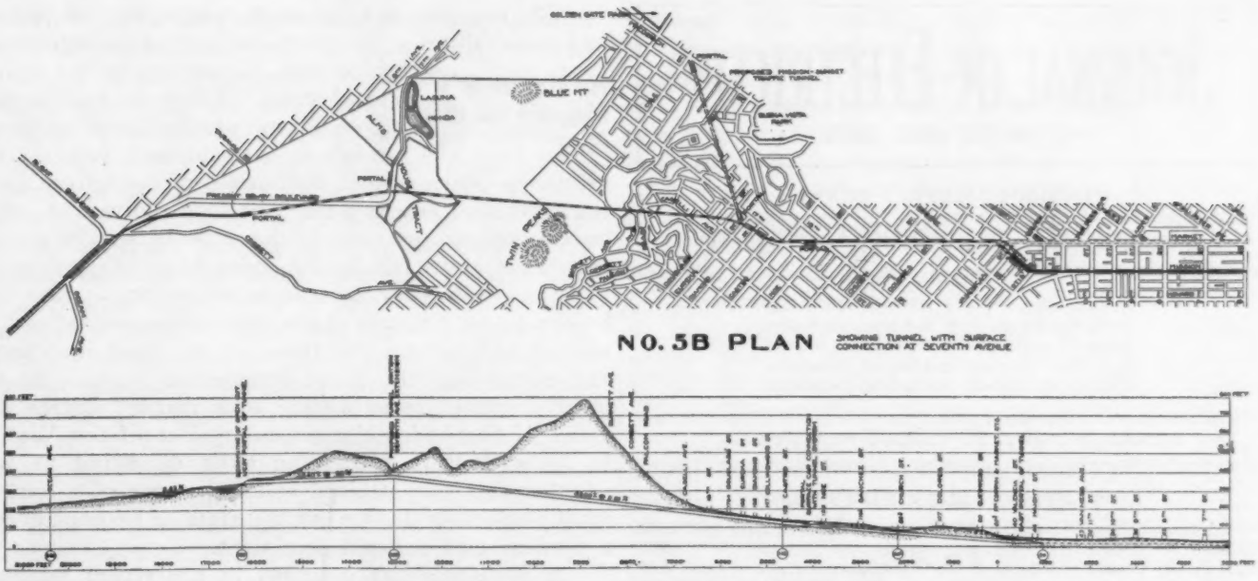
To handle the Exposition traffic it is recommended that the Fillmore street tunnel be built immediately, extending from Sutter street to Filbert street, 4,332 ft., with the necessary street widening at portals to preserve the roadways at either side for street cars, traffic and sidewalks. A tunnel through Devisadero will become a necessity at a later date. A single-bore tunnel could be built for about $2,000,000 and a double bore for $2,100,000. It is also suggested that a 2386 ft. tunnel be built under Broadway street with eastern portal at Mason and western portal at Larkin street. A short tunnel at Fort Mason would also be necessary, as well as a 1322 ft. tunnel under Stockton street. These, together with the proposed Twin Peaks tunnel are shown in the accompanying picture.

exits at Castro street and Seventh avenue. Both plans contemplate the eventual construction of a Market street subway. The latter plan would subdivide a 16,000 ft. tunnel into three parts with surface entrances not over 8,500 ft. apart.

For the main tunnel a 19 or 20 ft. arched roof bore is recommended while a flat-roof section should be used under Market street, not over 15 ft. in the clear with station platforms 15 ft. below the street crossings.

With a terminal at Valencia and Market streets it is suggested that the traffic can be effectively handled as follows:

Inter-urbans to be equipped with third-rail contact and routed direct to Valencia street underground, thence down Mission street on the surface.



Plan and Section of Proposed Twin Peaks Tunnel.

Suburban expresses to be routed the same as inter-urbans, using trolley to Valencia street.

Suburban locals to emerge at Castro, thence via Market street surface to the Ferry (or via Mission street.)

Surface feeder lines to enter the incline at Castro street, returning by an under-ground loop.

In the event of the extension of the subway to the Ferry, the entire subway bore will be available for both third-rail inter-urbans and subway locals, the suburbans being routed out of the bore at Castro or Valencia street, and the subway locals returning via underground loop at Castro street.

By the construction of this tunnel there will be brought within 30 minutes' running time of the business district, approximately 10,000 acres of new territory, 75 per cent of which is suitable for residence land, that has been practically useless heretofore by reason of lack of adequate transportation thereto.

This area extends west to the ocean front and south along the valley as far as the cemeteries. This estimate is based upon present operating schedules. But with higher speed equipment, even this is capable of great improvement and it is quite possible that the valley lands could be brought within the 30-minute zone at least half way to San Mateo.

THE ANNEALED COPPER STANDARD.

A report on copper wire tables has been made by the Bureau of Standards, Department of Commerce and Labor. The introduction states that copper wire tables are based on certain standard or assumed values for the conductivity or resistivity and the temperature coefficient of resistance of copper. When accuracy is important, the electrical engineer does not consult the wire table, but makes actual measurements of the resistivity of samples of the copper used. Frequently the resulting conductivity is expressed in per cent of the standard value assumed for conductivity. Per cent conductivity is meaningless without a knowledge of the standard value assumed, unless the same standard value is in use everywhere. But the same standard value is not in use everywhere, and confusion in the expression of per cent conductivity has accordingly resulted. The temperature coefficient of resistance is usually assumed as some fixed standard value, but the same standard value is not in use everywhere, and results reduced from one temperature to another have accordingly been uncertain when the temperature coefficient assumed was not stated. These conditions led the American Institute of Electrical Engineers to request the Bureau of Standards to make an investigation of the subject. This has been done and has resulted in the establishment of standard values based on measurements of a large number of representative samples of commercial copper—values which in certain respects are more satisfactory than any preceding standard values.

In the investigation it was discovered that the temperature coefficient is proportional to the conductivity. This new law has been corroborated by the Reichsanstalt, of Germany, and is of considerable importance in electrical measurements. It was also discovered that bending and winding a wire do not change the temperature coefficient, and consequently the internal temperature of electrical machinery may be calculated from resistance measurements with greater confidence than heretofore.

A proposal from Germany of a standard conductivity based upon this investigation has been accepted, and will probably soon be adopted all over the world. This new standard is a slightly lower conductivity than the former American value and the average of the experimental values published by the Bureau of Standards, but can be considered as substantially representative of average commercial copper.

This report gives a history of wire gages, showing that the trend of practice is toward expressing diameters directly in decimal fractions of an inch. The report contains 15 tables, including complete reference and working tables for annealed copper, both in English and metric units. Tables for copper cables and for hard-drawn aluminum wire are also given. The tables have been adopted as the official wire tables of the American Institute of Electrical Engineers.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company
Rialto Building, San Francisco

E. B. STRONG, President and General Manager
A. H. HALLORAN, V. P. and Managing Editor
ROBERT SIBLEY, Treasurer and Editor in Chief
C. L. CORY, Secretary and Special Contributor
A. M. HUNT, Director and Special Contributor

On Library Cars of all Southern Pacific Trains.

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.25

NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Errata Notice: *In the second paragraph, page 436, insert "1900 ft." as the fall from the south fork diversion to the Crane Valley reservoir and "850 ft." as the drop between Power House No. 3 and the intake of the second canal.*

An Engineer's Respect for the Flag

The engineer as a diplomat, as a commercial factor and as an arbiter in the courts occupies much attention in ethical discussions in the technical press. Little is said, however, as to whether the modern trend in concentrated power development leans toward inculcation of patriotism. In the strenuous efforts being put into centralized corporate organization, one of the most outspoken characteristics noticeable in the great body of men who make up this working scheme of action, is that of loyalty to the interests of the corporation coupled with respect and esteem for those at the head directing and upbuilding the great commercial fabric. Such loyalty imbued is noticeable to a marked degree in many of the hydroeelectric enterprises of the West. In view of this fact some have wondered as to whether this was attained at the expense of a somewhat slackening in love for the state or perhaps even a deadening of national sentiment.

A little incident occurred in the recent testing of the great turbine and boiler installation at Station C of the Pacific Gas & Electric Company in Oakland. The boilers were being forced to their utmost in a run for maximum capacity. Suddenly it was thought advisable to choke the draft slightly and for this purpose some old rags were placed in the peep holes at the front of the boilers. A few minutes later H. N. Mosher, chief engineer of the plant, entered, and, with a cry of "Boys, that's the American flag," proceeded to tear down the draft shield. The exciting moments that at once ensued in his rescuing this piece of fabric which was evidently the remnant of our national emblem, will not soon be forgotten by those who witnessed this little incident.

The whole affair took place in but a minute. To many the incident may perhaps seem of small moment, but to those endeavoring to analyze the trend of national sentiment and the effect of enginering ethical ideas upon this sentiment, it had a deep and significant meaning. Loyalty to one's task in life and to those at the helm directing that task is the essence of success in any enterprise, and when we realize that with this deep-seated development of loyalty is the far deeper inner man, ready to sacrifice a world beating boiler test if necessary for the sake of rescuing a tattered remnant of a national flag, something is aroused in our innermost which tells us that not only in practical affairs but in the imbuing of the highest ethical traits, the modern engineer makes good.

The Building of An Empire

Hydroelectric projects, calling for the ultimate investment of fortunes approximating nine figures, make one stop to consider the soundness of the business sagacity directing such vast outlays of money. Fully a dozen projects of this magnitude are now being financed for the West. Most of these are already assured and are in successful stages of operation, although for complete realization of the dreams of their promoters, the future must play its share in development of our natural resources.

Agriculture is the backbone of wealth for every country that looks toward permanency in prosperity.

While mineral wealth adds to the glory and lustre of power in a commonwealth, no panic nor financial stress can be felt over prolonged periods in a section actually producing the necessities of life within its confines. The continued development agriculturally of our western states is the charm that holds all observers. Montana, a state pictured mentally by most people as resourceful in vast wealth of mineral comes now to the front with agricultural products leading the mineral output in this great treasure state. And so it is in the other states of the West. Vast areas are being cultivated, which are found world-beating in their production per acre, and, yet, a generation ago our wise fathers at Washington doubted the wisdom of even extending a protecting hand to this arid country. So great has this wealth in agricultural development been, unquestionably millions of acres will continue to be reclaimed from their arid state. Gigantic powers are necessary to successfully pump water upon the rich bench lands awaiting but this magic touch to bear a blessing to our children's children.

Not alone is the agricultural development assuming amazing proportions. The cities of the West, bordering the great ocean of opportunity soon to be realized in the readjusting of the world's commerce upon the completion of the Panama Canal, are remarkable in their present building proportions. Last month, for instance, from Bradstreet's reports we read that of all the great cities of America, San Francisco, Portland and Los Angeles were surpassed in their building operations by only three—New York, Chicago and Philadelpia. When great muuicipalities, like St. Louis, Detroit, Pittsburg and New Orleans, are outdistanced by the striking upbuilding of these western cities, serious-minded men in the west can see much in store for the future outlook of these cities upon the arrival of the bidding time for the world's commerce. As another comparison, indicating the magnitude of this building preparation for 1915, the summing up of building for greater San Francisco, comprising the cities around the bay, is for the past month exceeded by only New York and Chicago.

Money put into substantial building structures becomes a permanent asset to a growing community. Such moneys, once having journeyed across the continent from the great eastern markets, become a fixed asset of the West never again to leave us. When we contemplate the enormous totals to which these monthly outlays will add by 1915, we get some conception of the greatness and substantiality of the building of our western empire.

The Electric Truck

Favorable comment on the rapid growth in the use of the electric truck is of almost daily occurrence in the technical press at present. To the careful observer the introduction of the electric truck is seen to be doing its share in solving a difficult problem brought about in the sudden and unprecedented increase of population in our western cities; namely, that of aiding in solving to a degree the congestion of the public thoroughfares in the overburdened traffic centers.

The owners of several large teaming outfits have found that the employment of electric trucks makes necessary only one-half the storage space formerly required. This is no mean item of economy in cities the size of Los Angeles, San Francisco, Portland and Seattle where real estate has assumed such valuations as to make even a small space of clear blue sky an expensive item at times. Far more noticeable, however, is the material lessening of traffic congestion in districts where electric trucks are beginning to become an increasing factor in numerical comparison with the time-honored "horsepower." The pliability in operation, the smallness of space occupied, and the rapidity of transit make the electric truck a welcome new-comer to such traffic congested thoroughfares as, for instance, Mission street in San Francisco. According to city ordinance, the heavy teaming of that municipality is diverted from Market street to this thoroughfare. To the pedestrian observing the long line of vehicles wend their way before him, flashes of reflective thought formulate in his mind an opinion of the superiority of the truck in lessening traffic congestion. When he wades in to thread his way through this tumultuous array, the "impedance" experienced with a number of teams met with as compared to an equal number of trucks encountered crystallizes this opinion into a firm conviction.

The installation of the electric truck in our western cities is too recent to obtain reliable data of operation, but it is interesting to note some of the cost data compiled in New York as detailed in a paper by Chas. A. Ward before the Electric Vehicle Association. A record was given of the operation for five weeks, or thirty working days of 100 1000-lb. Ward delivery wagons used by the Ward Bread Company. Of these vehicles eighty-five are equipped with lead cells and fifteen with nickel-iron cells. The tabulation of costs included all charging, repair, and garaging expenses, but not the items of depreciation, interest on investment or driver's wages.

The best record was made by a vehicle covering 25 miles per day at a total cost of $19.57 for thirty days. The worst record was made by a vehicle covering 28 miles per day at a cost of $64.21 for thirty days. The average for the 100 vehicles was 22 miles per day, 19.9 cents per day for charging energy, 1.82 cents per day for accidents, and 80 cents per day for garaging and maintenance, the total being $1.027 per vehicle per day, or 4.66 cents per vehicle-mile. The energy cost was estimated on the basis of 1.5 cents per kw.-hr., at double this rate it is seen that the total operating expense would be increased by only 20 per cent.

When vehicle statistics show costs of from 20 to 25c per mile, now necessary in the usual methods of horse conveyance, the positive saving in many cases of the complete purchase price of an electric truck in a season or two is thus assured.

On the other hand the wide-awake central station manager is not overlooking the possibility of enormous quantities of new power sales thus made within easy reach. The time when the central station manager looked solely to lighting output for new business has now passed.

The electric truck, then, as a factor in lessening storage space for traffic vehicles, as a material aid in solving our perplexing municipal congestion problems, as a money-saver for the consumer and a money-maker for the central station, is now with us. May all profit to the fullest extent by the opportunities offered.

PERSONALS.

H. P. Wilson of New York, who is secretary of the Great Western Power Company, is at San Francisco.

J. H. McGill of the McGill Manufacturing Company of Valparaiso, Ind., recently visited San Francisco.

Arnold Pfau, hydraulic engineer for the Allis-Chalmers Company of Madison, Wis., is at San Francisco.

R. S. Buck, of the firm of Sanderson & Porter of New York, spent the past week at Los Angeles on engineering business.

H. B. Squires of Otis & Squires, who has been visiting the Eastern factories for several weeks, is expected to return to San Francisco this week.

T. L. Phillips, transmission engineer for the Pacific Light & Power Company, has returned to Los Angeles after a tour of the Pacific Northwest.

A. L. Havens, the Los Angeles manager for Pierson, Roeding & Co., spent a few days at the firm's San Francisco office during the past week.

F. C. Finkle, an engineer who has been connected with Southern California hydroelectric developments for some time, recently visited San Francisco.

J. C. Temple, the Chicago manager for the Morgan-Smith Company of York, Pa., manufacturers of water wheels, is at San Francisco on contract business.

H. V. Carter, president of the Pacific States Electric Company, is making an eastern trip and will be present at the Atlantic City jobbers' convention.

C. D. Wheeler, publicity manager for the Fort Wayne Electric Works of the General Electric Company, is attending the Shriners' convention at Los Angeles.

John A. Britton, vice-president and general manager of the Pacific Gas & Electric Company, is expected at San Francisco next week on his return from a flying trip to Yokohama.

H. E. Sanderson, Pacific Coast manager for the Bryant Electric Company, has returned to his headquarters at San Francisco after an extensive trip through Oregon and Washington.

Morgan B. Speir, division commercial superintendent of the Southern Bell Telephone Company, with headquarters at Charlotte, N. C., is at Portland, Ore., after making a tour of California.

C. F. Ubelacker, chief engineer for Ford, Bacon & Davis of New York, is visiting the firm's San Francisco office while making a tour of the Pacific Coast on general engineering business.

H. D. Donnell, representing the Safety Car Heating & Lighting Company on the Pacific Slope, has returned to his San Francisco office after a business trip to Denver via Salt Lake City.

N. W. Graham, who is in charge of the Holabird-Reynolds Company's store at Los Angeles, has left for the East and will attend the electrical jobbers' convention at Atlantic City, N. J., in June.

F. A. Somers, who now has the title of manager of the railway and lighting division of the Westinghouse Electric & Manufacturing Company's San Francisco office, recently visited Southern California.

Wynn Meredith, of the San Francisco office of Sanderson & Porter, has just returned from Vancouver, B. C., after inspecting the engineering work which is being conducted under the supervision of his firm.

W. S. Berry of the Western Electric Company's San Francisco office, has left for Chicago and the Eastern states. He will visit Atlantic City during the forthcoming convention of the electrical jobbers.

Rudolph W. Van Norden, consulting engineer, has removed his offices from the Nevada Bank Building to the Rialto Building, San Francisco. He spent the past week investigating the Clear Lake power project.

Sidney Sprout, engineer for the California-Oregon Power Company, has gone to Siskiyou county on work connected with the new development on the Klamath River for which machinery contracts were recently awarded.

B. C. Carroll, general agent for the Pacific Telephone & Telegraph Company, has returned to San Francisco after spending two months at Seattle and Northwestern points. He reports a rapid growth of business at Portland.

P. W. Greenleaf, formerly superintendent of the Pacific Power Company at Mono Lake, Cal., has resigned to accept a position with the Southern Sierra Power Company at Paris, Cal. W. K. Bellinger of Los Angeles has succeeded to his position.

H. B. Smith, professor of electrical engineering at Worcester Polytechnic Institute, is a recent San Francisco visitor. Mr. Smith is just completing a year's trip around the world, during which he has visited many of the great hydroelectric enterprises of the Orient.

Thomas Mirk of Hunt, Mirk & Co. has returned to San Francisco from Portland. **K. G. Dunn,** representing this firm, was at Tulare last week when the new steam plant of the Tulare County Light and Power Company was accepted by the owners, after a successful test run.

Garnett Young, manager of the Telephone-Electric Equipment Company, is at Los Angeles on his way home from the East after attending the annual meeting of sales managers of the National Metal Molding Company at Pittsburg and visiting the factories represented on the Pacific Coast by his firm.

C. H. Rattray, electrical engineer, with the General Electric Company, Colman building, Portland, is actively engaged in collecting pumping data regarding practices and costs of systems for irrigation work. This is in connection with one of the largest propositions yet projected in the Greater Northwest.

J. B. Lukes of the engineering staff of the Stone & Webster Company is at San Francisco to open an office at 413 Rialto Building.. Among the representatives of Stone & Webster forces who visited San Francisco during the past week are: **E. B. Bumsted,** engineer; **H. A. Hageman,** chief designer of the Fresno office, and **D. L. Roberts,** in charge of the field commissary department.

Newcomb Carlton, vice-president of the Western Union Telegraph Company, arrived at San Francisco from the East during the past week on an inspection tour. He was director-general of the Pan-American Exposition at Buffalo. He visited the Panama-Pacific International Exposition site as a guest of the exposition directors.

B. C. Condit, engineer for the Northwestern Light & Power Company, a Fleishhacker enterprise, is at San Francisco. He is interested in closing contracts for hydroelectric generating machinery for its new developments to transmit power to Portland, Ore., on a large scale. Bids are in for two 10,000-kw. generating units.

Samuel G. McMeen, member of the engineering firm of McMeen and Miller of Chicago, recently was elected president of the Columbus Railway & Light Company of Columbus, Ohio. The Columbus Railway & Light Company operates all the electric traction, lighting and power properties of the Columbus Edison Company, the Columbus Light, Heat & Power Company, the Columbus Traction Company and the Columbus Railway Company. Mr. McMeen's new connection is a promotion from the presidency of the Mt. Hood Railway & Power Company of Portland, Oregon. He remains a partner of the firm of McMeen and Miller.

IN MEMORIAM.

Hinsdill Parsons

As the result of an automobile accident, Hinsdill Parsons, vice-president and general counsel of the General Electric Company, was instantly killed near Albany, N. Y., Sunday afternoon, April 28th.

Although but 48 years of age, Mr. Parsons had shown himself to be one of the ablest corporation lawyers in the country. For nearly a dozen years he has had charge of the law department of the General Electric Company, and his abilities have been well proven in the solution of the many perplexing legal problems which naturally arose in the development of this rapidly growing industry.

In 1907 Mr. Parsons took an active part in the work of the rehabilitation of the Knickerbocker Trust Company, later becoming one of its directors,—a position from which he later retired.

He was largely responsible for the remarkable development of the Schenectady Railway Company, the Schenectady Illuminating Company and the Mohawk Gas Company—being president of the two last named companies at the time of his death.

Mr. Parsons was a director of the Electric Bond & Share Company, the Washington Water Power Company and the Schenectady Power Company.

Mr. Parsons maintained a residence in Schenectady where he spent considerable time during the summer, but his business affairs kept him in New York City much of the time.

Mr. Parsons was a member of the Mohawk Club and the Mohawk Golf Club of Schenectady, and was deeply interested in many other local organizations. He was also a member of the University, Metropolitan, St. Andrews, and St. Nicholas Clubs, and of the Down Town Association in New York City. He had a wide circle of friends among the leading legal and electrical men of the country who mourn his loss. He was deeply loved by all his friends and by all who knew him.

Hinsdill Parsons, a son of the late Mr. and Mrs. J. Russell Parsons, was born in Hoosick Falls, February 10th, 1864 and received his higher education at Trinity College and at the Albany Law School, graduating from the latter in 1885. Four years later he was appointed patent attorney for the Walter A. Wood Harvester Company of Hoosick Falls. He became associated with the General Electric Company in January, 1894, and in April 1901 he was elected vice-president.

As head of the law department, Mr. Parsons directed the legal affairs of the company and was assisted at the Schenectady office and in New York by a large staff of lawyers.

He is survived by his wife, Jessie Mary Burchard, who is a sister of Anson W. Burchard, who holds the office of assistant to the president of the General Electric Company. Also by three brothers, Willard P. Parsons of Cohoes, and Edgerton and Walter Wood Parsons, both of New York City.

The funeral services were held from St. George's Church, Schenectady, Tuesday afternoon, April 30th.

J. P. Ludlow, who was connected with J. G. White & Co. as an appraiser, was injured in an automobile accident which caused his death May 7th. While returning to Bakersfield from an electric power plant which he had inspected, the automobile in which Ludlow was riding plunged over a forty-foot embankment. He was taken to Bakersfield and given the best attention, but failed to rally. He leaves a widow, who resides at Berkeley.

SAN FRANCISCO ELECTRICAL CONTRACTORS' NOTES.

The bids for the Tivoli Opera House on Eddy street ran too high and the plans are being revised.

The John G. Sutton Company has been awarded the electrical work on the Fleishhacker Building on Bush street and Grant avenue.

The Central Electric Company has been awarded a contract for wiring a large warehouse for the Blinn Estate on Second and Brannan streets.

Fred Greisberg, formerly superintendent of construction for the Decker Electric Company, has entered the electrical contracting business with headquarters on Golden Gate avenue.

The electrical workers in Portland are striking for higher wages. Paul Butte of the Butte Engineering & Electric Company and H. C. Reid of the Pacific Fire Extinguisher Company are both there looking after the interests of their companies, who have several large jobs.

TRADE NOTES.

The offices of the Bowie Switch Company and A. J. Bowie Jr. have been moved from the Lick Building to 913 Nevada Bank Building, San Francisco.

The Holabird-Reynolds Company have been made the sales agents of the Schwarze Electric Company of Adrian, Mich. They manufacture high-grade electric bells.

Ray D. Lillibridge, incorporated, specialists in technical advertising, announce the removal of their offices to suite 2109-10-11-12 Trinity Building, 111 Broadway, New York City.

The Portland Railway, Light & Power Company, Portland, Ore., will soon install new transforming apparatus in its stations consisting of six 750 kva., 11,000-2400 volt units which have been ordered from the General Electric Company.

The McGill Manufacturing Company, after carrying a stock of their lamp guards, solder-flux material, etc., in San Francisco for some time, have discontinued their local agency. The stocks have been taken over by the Pacific States Electric Company, the Western Electric Company and the Holabird-Reynolds Company.

The Pelton Water Wheel Company has sold to the Grangeville Electric Light and Power Company a 550-h.p. Pelton-Francis turbine water wheel of the horizontal, cylindrical, steel-encased type, to operate at 600 r.p.m. under a head of 59 feet. The new generating unit will be a duplicate of one that has been in operation about two years at the Grangeville plant.

The Pacific Gas & Electric Company has outgrown its big office building and additional offices and display rooms are being fitted up in the building formerly occupied by the Metropolitan Light & Power Company at 422 Sutter street. H. P. Pitts, industrial agent for the company, and John H. Hunt, purchasing agent, will remove their departments to the new location.

The General Electric Company has the contract for supplying and installing the electrical equipment for the new planing mill of the Stimson Mill Company at Ballard station, Seattle. This will include a 1500 kilowatt steam turbine generator and about 50 motors, aggregating 1600 horsepower. The generator is a 3-phase, 60 cycle type, being direct connected to the Curtis steam turbine.

The executive offices and New York show rooms of the H. W. Johns-Manville Company, manufacturers of asbestos, magnesia and electrical supplies, were moved on April 20th to the new twelve-story "H. W. Johns-Manville Building," Madison avenue and Forty-first street, New York City, from their old quarters at 100 William street, where they have been located for the past 15 years.

The Holophane Company and the Fostoria Glass Specialty Company have been consolidated into one organization to be known as the Nelite Works of General Electric Company, with headquarters in Cleveland, Ohio. The factories will remain in Fostoria and Newark. The Holophane Engineering Department will also remain in Newark for the present. The removal of sales and accounting departments and the change of name takes place as of April 29, 1912.

The Electric Storage Battery Company of Philadelphia has recently closed a contract with the New York Edison Company for the installation of four additional "Exide" batteries to the forty-five batteries this company now has in service. This contract is the largest ever made for storage batteries in central station service, the four batteries having a capacity at the emergency rate of 138,620 amperes. One of these batteries will be the largest central station battery in the world, having an emergency output of 48,140 amperes. All of the 49 batteries for the New York Edison System have been built and installed by The Electric Storage Battery Company. They have an output at the one hour rate of 158,330 amperes.

BOOK REVIEWS.

Alternating Current Design. By Julius Frith, M. Sc., M. I. E. E., Size 5½ x 8½ ins.; 115 pages; 27 illustrations; cloth binding. Published by D. Van Nostrand Company of New York, and for sale by the Technical Book Shop, Rialto Building, San Francisco. Price, $2.00.

In the preparation of this book, the author, Julius Frith, who is a consulting engineer and special lecturer in electrical design in the Manchester University, has aimed at the compilation of a companion book to Mr. Cramp's "Continuous Current Machine Design." Armature reaction and the relation of dimensions to output occupy two of the fourteen chapters. An illustrative example of the design of an alternator next follows. The induction motor, the transformer and transmission lines with choke coils and other accessories are taken up in able and logical order. Severe mathematical deductions are avoided. Emphasis of the inward physical meaning is effectively brought out in the development of the theory of design. The book will be found of much practical use to those engaged in design and especially for students in design.

Engineering Valuation of Public Utilities and Factories. By Horatio A. Foster, author of "Electrical Engineers' Pocketbook." Size 6 x 9 in.; 345 pages; replete with tables and form sheets. Published by D. Van Nostrand Company of New York, and for sale by the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $3.00.

No more welcome book has appeared for some time than this excellent treatise on engineering valuation of public utilities. The recent action of the California State legislature in putting public utility corporations under the control of the State Railroad commission is typical of the trend of the times. Mr. Foster as author of the well-known Foster's Electrical Engineers' Pocketbook speaks with the authority and experience of a lifetime devoted to compiling data of vital interest to the electrical engineer. The book is systematic and logical in its arrangement. The first chapter deals with "value" and its various ramifications. Such terms as tangible and intangible assets, obsolesence, amortization, good will, going concern, depreciation, appreciation, franchise value and capitalization are treated in the fullest manner. The final three chapters are devoted to control of public utilities, court decisions and bibliography. The form sheets taken largely from the Wisconsin Commission standards add a completeness to the work lacking in recent books and papers along similar lines. The book is invaluable to engineers dealing in any way with valuations of public utilities or with questions of rate making.

The Art of Illumination. By Louis Bell, Ph. D. Second Edition; thoroughly revised, enlarged and reset. Size, 6x9¼ in.; 353 pages; 171 illustrations; cloth binding. Published by McGraw-Hill Book Company and for sale by the Technical Book Shop, Rialto Building, San Francisco. Price $2.50.

The art of illuminating engineering has been enriched by a large amount of valuable experience within the past few years, and its principles are now founded on a more secure scientific basis. In the detailing of these principles in clear, lucid, simple style it is doubtful if any American author is the equal of Dr. Louis Bell. There is something in his charm of expression which makes dry facts and figures not only profitable reading but intensely interesting. This book has been thoroughly rewritten and brought down to date and may be said to represent the last word on illumination. The author starts out by describing the natural characteristics of light in its physiological relation to the human eye. Then follow the principles of color, reflection and diffusion. After treating next the subject of standards in light and photometry the various lamps with their reflectors follow. Exterior and interior illumination is interestingly discussed. The book is technical and yet so artfully written, the layman or at least one versed but little in affairs electrical can understandingly read it. To any one interested in the live subject of illumination, a library without it present is most incomplete.

A. S. C. E. CONVENTION NOTE.

Pacific Northwest Society of Engineers, Captain A. O. Powell, president, is co-operating with the local committee of the American Society of Civil Engineers for the entertainment of the members of the latter society at its annual convention in Seattle, June 25-28, 1912. The Northwest Society has appointed the following co-operating committee: J. T. Heffernan, chairman; Robert Moran, Dean Milnor Roberts, George P. James, Henry L. McGillis, A. B. Coe, Stirling B. Hill and M. J. Falkenburg.

AMERICAN ELECTRIC RAILWAY ASSOCIATION REPRESENTATIVES VISIT THE WEST.

Traveling 8000 miles, traversing 30 states and visiting 29 cities is part of the general plan of the officers of the American Electric Railway Association.

These men were banqueted at the Palace Hotel in San Francisco on Friday evening, after having enjoyed a pleasant and profitable sojourn in Los Angeles. They will visit Portland on May 14. From there they will visit Vancouver, B. C., after stopping in Seattle.

As the officials of the American Electric Railway Association the 12 or 14 men represent 1300 electric railway companies which own 42,000 miles of track, 90,000 cars, and carry annually between 10,000,000,000 and 11,000,000,000 passengers. These companies employ 250,000 persons.

The party left New York in the private car Advance on April 17, and they expect to step off the same car in the same city at 9:30 on the night of May 29.

"We are traveling across the country to bring about a better understanding between the electric railway companies and the communities they serve," said Thomas N. McCarter, president of the association, recently. "We want to enable the railway companies to appreciate more fully the benefits which these two associations bring to them along the lines of standardization and efficiency."

Mr. McCarter is at the head of the Public Service Corporation of New Jersey.

INDUSTRIAL

SPARK GAP LIGHTNING ARRESTERS.

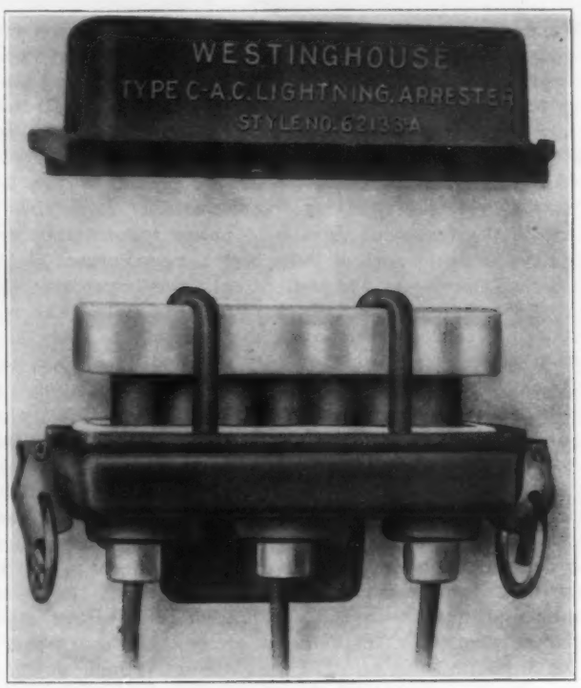
Static protective apparatus, to be effective, must act exactly like a safety valve; it should allow no current to pass at the ordinary pressures, but at undesirable pressures above normal it should provide sufficient freedom for the flow of current to limit the pressure to safe values, and it should cease to take current and resume its inactive condition the instant the excessive pressure is relieved. The simplest and therefore the least expensive form of lightning arresters that fulfill these functions are of the spark gap type.

Type MP Lightning Arrester.

The illustrations show two types of spark gap arresters for low-voltage use, manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. The type MP is used on cars, on lines, and in stations, for railway service, and the type C is an inexpensive device for the protection of overhead lines.

The type MP or multipath arrester, for use on 440 volts alternating current or 600 volts direct current, has for its working part a block of special composition, over the surface of which the discharge spreads itself along a number of minute discharge paths. The voltage across each gap is very small, but owing to the large number of gaps the line voltage can not maintain an arc across them. The arrester has an indefinitely long life and affords a freedom of discharge very great compared with ordinary air spark gap types.

For installation under various conditions, three different styles of enclosing cases are furnished for the type MP arrester. In all three the cases are of galvanized iron and substantially constructed. The covers close against felt gaskets and are held by rugged spring-toggle latches. The car mounting style is so constructed that when the cover is removed the working part comes out with it; it is therefore convenient for mounting under car sills and in other inaccessible places. The pole-mounting style has the mounting lug located at the bottom, so that the cover can be removed for inspection without dropping out the working part. The conduit-wiring style is mounted in a larger box having a conduit hole tapped with standard ⅜-in. pipe thread; the ground lead is connected directly to the box, and the conduit system should be grounded.



Type C Lightning Arrester.

About five type MP arresters per mile are recommended by the manufacturers for line protection, and one on each car.

The type C arresters, for 500 to 2500 volts alternating current, consists of seven cylinders of non-arcing metal mounted between overhanging porcelain supports and enclosed in a weather-proof iron box. Leads are brought out from the first, last, and middle cylinders. For lines up to 1250 volts, one arrester can be used as a protection for both sides of a two-wire circuit, the middle lead being grounded. On higher voltage one outside lead is grounded and the arrester is single-pole. The static charge spreads over the surface of the cylinders and jumps across the gaps between them. This lightning arrester, because of the large size of the cylinders, has an instantaneous current capacity that materially aids in clearing the line of disturbances, while its equivalent spark gap is extremely low. This device has successfully withstood the test of hard conditions and gives reliable protection under the conditions for which it is intended.

The type C arrester is intended for use on circuits having a capacity not exceeding 200 kilowatts if installed within a radius of two miles from the source of power. An additional capacity of 100 kilowatts is permissible for each additional mile. These limits are specified by the manufacturers to allow for the ability of the arrester to successfully suppress a power are following a discharge.

A NEW CURRENT TRANSFORMER FOR HIGH VOLTAGE SERVICE.

BY S. P. RUSSELL.

To those familiar with the current transformer, the tedious description of the inter-related electric and magnetic paths and their various uses would be as tiresome to the reader as to the writer. Volumes of analysis have been written and are easily accessible to those who desire such, some of the best being procurable at the Bureau of Standards, Washington, D. C.

The current transformer dates back to the beginning of alternating current practice, but it has lagged behind other electric apparatus in design, finish and reliability. Originally it was a safety device, permitting the removal of dangerous wires from the switchboard, and from direct contact with all instruments that might be handled.

When the high tension transmission systems were first placed in service, no current transformers were developed for such severe duty. There were many other pressing problems to solve, without trying to do much with relays, meters or automatic switches on the main line, and hand control was the rule of operation. All current was metered at the generator voltage, or else the meters were placed on the low voltage side of the receiving transformers.

With the enormous growth of power transmission systems, and their network of lines, high voltage current metering became necessary and the current transformer was also wanted for the operations of relays and trip coils. The percentage of failure that followed the trial of the early high tension current transformer greatly retarded its general use. Its weakness was in the design and method of insulation.

Its lack of efficiency is well illustrated by the following story related by a friend, who stated that on a recent trip to Los Angeles, while in conversation with an engineer, the statement was made (and seriously), that they could set their watches by the current transformers. On being pressed for an explanation, the engineer stated, that at some critical stage or condition of the load at regular intervals, one or more high voltage current transformers would have its "baptism of fire," with the usual accompaniment of interrupted service, etc. This story, of course, is an exaggeration of facts, but it is so far true that current transformers for high voltage service are in bad order, due to excessive cost and unreliability, that they are omitted in many cases where it is a real hardship to do without them.

These conditions demanded something better, with the result that there is now on the market a current transformer which is practically immune, and which lacks the time keeping quality of its predecessors. This transformer is unique, standing alone in an apparent contradiction of all supposedly sensible and reasonable apparatus, and performing the duties for which it was conceived, i. e., a reliable twenty-four hour a day means of registering the power flowing in high tension power lines. Fewer parts and a simpler construction cannot be obtained, and this piece of apparatus is considered final in the essential qualities of simplicity, permanent high insulation and safe operation.

The current transformer is comprised of outlet bushing with copper bar terminals,—or primary leads, molded in. This bushing is mounted on the cover, and in turn supports the transformer carcass in the following novel manner: The carcass is comprised of one porcelain bushing, one primary coil, two secondary coils, one cast copper shackle (in two parts), and the laminated iron core.

The bushing is recessed at both ends to admit the secondary coils, and the outside waist of the bushing is contracted to hold the primary coil. The two parts of shackle are insulated from one another by suitable fibre blocks and bushings, and the insulating coupling held together with two bolts passing through metal flanges, fibre block and bushing, thus making a strong rigid shackle, which is bolted to the primary leads. The two ends of the primary coil are electrically connected to the shackle in such a manner that the shackle is always one turn of the primary winding, i.e., part of the first, and part of the last turn. With the laminated iron core passing through the bushing and suspended therefrom, we have the novel condition of a transformer hanging by its primary leads.

By this simple means of suspension the task of insulation is so much lightened as to be easily accomplished. The secondary leads are brought out through a rigid metal conduit which is attached to the cover, which results, when removing the cover, in the removal of the whole transformer. This is so light that with the exception of the 100 kw. transformer, one man can easily handle it.

The tank is a one-piece boiler plate, acetylene-welded tank, and the assembled transformer filled with clean dry mineral seal oil is practically indestructible when subjected to the service for which it is intended.

This transformer is patented, and is made for three principal voltages, i.e., 40,000, 60,000 and 110,000 volts. It is built for any range of current from 5 to 500 amperes, the secondary coils being wound for 5 amperes on all sizes.

This is sold exclusively by the H. W. Johns-Manville Company, who are manufacturing it in indoor and outdoor types in all voltages up to 150,000 volts.

NEW CATALOGUES.

In Circular 202 the D. & W. Fuse Company of Providence, R. I., have published interesting and valuable information on Magnetic Chucks for machine shop use.

The latest bulletin the Kellogg Switchboard & Supply Company have to offer the telephone trade, is the Number 60, on Construction Material, Tools and Miscellaneous Supplies. Every effort has been made to list in this bulletin, the best materials, apparatus, etc., of proven merit.

The Westinghouse type T direct-current turbo-generator, consisting of a Westinghouse steam turbine direct-connected to, and mounted on, a common base with a direct-current generator, is fully described and illustrated in Descriptive Leaflet 2458 just issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. A full description of the various characteristics and construction details of the turbine is given, and numerous views of the component parts of the various elements, the completed machines, and installations are shown.

The General Electric Company has issued a number of new Bulletins. No. 4922 is devoted to Electriicty in Metal Mines and contains illustrations and descriptions of d.c. and a.c. apparatus for every phase of mining work. No. 4933 describes Small Polyphase Motors, Riveted Frame Construction, No. 4934 is concerned with Battery Charging Rheostat and No. 4935 with the G. E. 201-A Railway Motor. No. 4941 gives an exposition of the theory and use of Water Flow Meters. No. 4942 relates to the Thomson Direct Current Test Meter. No. 4943 to D. C. Motor Starting Panels for Heavy Service and No. 4944 to Isolated and Small Plant A. C. Switchboard Panels.

The Kellogg Switchboard & Supply Company have just issued several interesting pamphlets. "Some 1912 Acknowledgements of Unsurpassed Kellogg Service," contains many sincere and strong testimonials in favor of Kellogg apparatus in use throughout the world. The booklet contains 16 pages with a buff colored border design for each page. Kellogg Moisture Proof Cords are described in two four-page folders, one in English and one in Portuguese. Information given in these little folders will interest many operators who have the problem of cord inefficiency with which to contend. A second edition of the little booklet entitled "Things Telephone Users Should Know About Telephone Systems and Service," is another of their recent publications.

NEWS NOTES

INCORPORATIONS.

KENT, CAL.—The Kent Electrical Manufacturing Company, $5000, by A. A. Risedorph, George Schurman and others.

SAN FRANCISCO, CAL.—K. P. F. Electric Company, $20,000, shares $10 each, subscribed $30, by A. S. Kalenborn, A. J. Pohl, J. B. Francis.

SAN FRANCISCO, CAL.—Bachman Electric Company, $10,000, shares $2 each, subscribed $104, by J. N. Bachman, J. Lynch and L. Crowley.

SAN FRANCISCO, CAL.—Domestic Water Company of Santa Maria, $150,000, shares $100 each, subscribed $300, by C. H. Zeus T. A. Allan and A. B. Eddy.

DEL NORTE, CAL.—Mountain Power Company, $1,500,000, by F. P. Brewer of Pasadena, Carrie M., H. S. and J. S. Owen of Los Angeles and F. D. Stout of Chicago.

POMONO, CAL.—Articles of incorporation have been filed for the Limited Mutual Water Company, with capital stock of $20,000. Directors are Chas. W. Churchill, L. W. Cushman and F. A. Squires. The lands in the incorporation are about midway between Upland and Claremont. The company is organized to drill and excavate for water.

ILLUMINATION.

WALLOWA, ORE.—A deal has been consummated whereby Geo. Jacobs of Portaind becomes the owner of the Wallowa Light & Power Company.

PORTLAND, ORE.—The taxpayers of the city of Vale have authorized an electric light and power franchise for the Idaho-Oregon Light & Power Company.

ANTIOCH, CAL.—The Pacific Gas & Electric Company has begun serving the people of Oakley, Knightsen and Brentwood with electric light and power.

DEER PARK, WASH.—F. E. Parks and some leading business men of this place are organizing a light and gas company and have asked for a 25-year franchise.

BURBANK, CAL.—Sealed bids will be received up to May 25 for a franchise to build and maintain for 40 years, an electric light and power system under and along the streets of this city.

GLENDORA, CAL.—Sealed bids will be received up to June 4 for a franchise to erect and operate for 50 years, piers, masts, poles and other structures transmitting electricity, in and along certain streets.

PORTERVILLE, CAL.—A franchise has been granted to the Home Gas Company for a period of 50 years to construct and maintain a system of gas pipes along all public roads and highways within the city.

AMERICAN FALLS, IDAHO.—The total expenditure for the erection and equipment of the new power house to be erected by the Idaho Consolidated Power Company, at this place, will reach the $1,000,000 mark when completed.

OXNARD, CAL.—First steps have been taken toward the issuance of bonds in the sum of $30,000 for the construction and completion of a municipal street lighting system. Said bonds shall be 60 in number, of $500 each, bearing 5 per cent interest, payable semi-annually on May 1 and November 1. Two of said bonds shall be payable May 1, 1922, and two on same date each year thereafter until all are paid.

PORTERVILLE, CAL.—The Central California Power Company has petitioned the Railroad Commission for the grant of an application for a stock and bond issue of $40,000 with which to purchase the properties of the Home Gas Company for $40,000 in Porterville and the franchises in Exeter and the franchise in Tulare County. The Commission will hear the application on May 7, spending the morning in Exeter and the afternoon in Porterville.

SAN FRANCISCO, CAL.—The Oro Electric Company, successor of the Oro Water, Light & Power Company, has placed on the market here $3,500,000 first mortgage bonds, the proceeds from the sale of which will be devoted to the development of gigantic power projects in Superior California. The company operates at present two hydroelectric plants in the Sierras with a capacity of 4009 h.p. and about 50 miles of distributing system, and furnishes electricity for light and power in Oroville and the adjacent country, besides owning all of the electric, gas and water business in Oroville and vicinity.

WALA WALLA, WASH.—The efforts of the city of Pendleton to secure a municipal power plant to the Walla Walla River above Milton are apt to meet with a severe and permanent setback, if the plans of a number of the property owners along the stream are carried out. The plan of the property owners, according to the current report, is to take water from the Walla Walla River just below the tailrace of the Pacific Power & Light Company, and erect a power plant for the purpose of erecting, which the Walla Walla River Power Company has been organized and incorporated. The representatives of the new company have secured plats of the proposed pipe line of the Pendleton proposition, and the idea is to block the efforts of the county seat people in securing a right of way for the line.

TRANSMISSION

BOISE, IDAHO.—The Southern Idaho Light, Heat & Power Company will extend its interurban line from Caldwell to Ontario and Weiser. R. L. Ewing is the engineer in charge.

VICTORIA, WASH.—It is reported the contract with the Westholm Lumber Company to put in the Sooke Lake power plant has been canceled by the city authorities. This work involves several million dollars. It is supposed the work will be advertised.

KLAMATH FALLS, ORE.—The California-Oregon Light & Power Company, which will build a dam 90 feet and 250 feet long to generate electric power for the surrounding country, has awarded the contract to furnish 50,000 barrels of cement to the Big Basin Lumber Company of this city.

SALEM, ORE.—With developments in the office of State Engineer Lewis today it is practically certain that a gigantic fight is being waged between the Hill and Harriman lines to secure one of the greatest power assets in the Willamette Valley. The fight is waging over power possibilities in Clear Lake and the McKenzie River. The Southern Pacific recently filed with the State Engineer asking to use the waters of Clear Lake and McKenzie River for development of 36,000 horsepower, using 400 second feet and a fall of 800 feet, the improvements to cost in the neighborhood of $1,600,000. But this filing was apparently balked by a prior filing of the McKenzie Valley Irrigation & Power Company, which asked for water for irrigation as well as power.

LOS ANGELES, CAL.—C. A. Blackmar, head of the de-

partment of oil inspection is preparing an ordinance which he will soon submit to the City Council, regulating the laying of oil pipe lines in the city. There are now within the city more than twenty-five miles of oil pipe lines, ranging from four to ten inches. Each is laid according to its owners' own specifications. Future pipe lines will be laid according to the city's plans, if this ordinance is adopted. The present lines frequently break, because of electrolysis; but special provision will be made to avoid this trouble, and provision will also be made for the placing of gates at certain intervals, so that when there are breaks the oil can be shut off readily and damage may be minimized.

TRANSPORTATION.

PORTLAND, ORE.—It is reported that the Southern Pacific Company has bought the A. Welsh electric lines in Willamette Valley, including the Salem street car system.

CORVALLIS, ORE.—At the last meeting of the City Council a franchise was granted to the Portland, Eugene & Eastern Railway Company. The company will start work at once.

SAN BERNARDINO, CAL.—Bids will be received up to May 27, for the purchase of a franchise to construct and operate for fifty years an electric railroad over and across certain streets of the city.

VANCOUVER, B. C.—The British Columbia Electric Railway Company announces it will start the construction of a line from Main street west on Sixteenth avenue, along the boundary of Point Grey. The work will be rushed to completion.

SAN FRANCISCO, CAL.—Prominent electric railway men, headed by T. H. McCarter, president of the American Electric Railway Association, and president of the public service corporation of New Jersey, visited San Francisco this week. The delegation consists of twelve.

MERIDIAN, CAL.—Work on the new $300,000 bridge across Butte Slough for the Marysville and Colusa branch of the Northern Electric Railroad Company, will be started soon. The contract for the foundation has been let. The total amount of the contract will run close to $100,000.

OAKLAND, CAL.—Announcement is made by officials of the Southern Pacific Company of the awarding of contracts for the grading and road work on the Melrose-San Leandro extension of its transbay service. Actual construction of the work will be commenced within two weeks.

PORTLAND, ORE.—A 1200-volt electric system copied after its Oakland and Berkeley, Cal., interurban lines, will be installed by the Southern Pacific on Fourth street, here, if the City Council grants its application to electrify the line, according to A. H. Babcock electrical engineer for the Harriman railroads.

SAN FRANCISCO, CAL.—The Geary Street Railway ceased operations on May 5, and the work of constructing the new municipal road started the next day. Except for the short line to the beach, the new contract embraces the completion of the entire roadbed. Mahoney, the new contractor, is allowed 180 days to finish the work and will be given $200 for each day which he saves under the specified time. He has announced that he intends to get the bonus and that he will make the "dirt fly."

SACRAMENTO, CAL.—Application for permission to construct ten public road crossings at grade has been made by the Northern Electric Company to the State Railroad Commission. It is the first application of the kind to be filed with the Commission and complies with the provisions of the new public utilities law making it necessary for a railroad to obtain the Commission's permission before constructing a crossing on a level with a public highway. These crossings are on the Northern Electric extension from Marysville to Colusa.

SEATTLE, WASH.—Charging that a conspiracy exists between Trustee Augustus S. Peabody, Peabody, Houghteling & Co., and other financial interests to deprive him of his $1,000,000 worth of stock in the Seattle, Renton & Southern Railway, William R. Crawford, president of the company, has procured the appointment of Scott Calhoun as temporary receiver for the railway company. Judge King Dykeman made the order requiring the defendants to appear in court on Friday at 1:30 p. m. and show cause why the receiver's appointment should not be made permanent. In his complaint filed, Mr. Crawford asks judgment against Augustus S. Peabody, and Peabody, Houghteling & Company, for $1,000,000 damages. The action is directed against these, and the railway company and the First Trust & Savings Bank of Chicago.

SAN FRANCISCO, CAL.—The annual report of the United Railroads for 1911 shows an increase in gross earnings of $232,647 and an increase of net earnings over 1910 of $254,947. The 1911 gross earnings amounted to $7,886,136; the net reached $3,179,165. The total income of the United aggregated $3,443,792, an increase of $429,295, and its expenses and taxes amounted to $4,706,971, a decrease of $22,299. The sinking funds aggregated $339,619, a decrease of $27,451, and the surplus is shown to be $1,008,960, an increase of $407,051. Out of $1,008,960 surplus of 1911 $473,168 was paid out for renewals, depreciations and contingencies, and $350,000 for dividends on first-preferred stock. Filed with the United Railroads' report was the income account of the Sierra & San Francisco Power Company, for 1911, as follows: Gross earnings, $834,324; expenses and taxes, $258,271; net earnings, $576,053; charges, $328,326; net income before depreciation, $247,727.

PORTLAND, ORE.—The Portland Railway, Light & Power Company has sold $5,000,000 5 per cent 2-year notes to J. & W. Seligman Company of New York and E. W. Clark & Company of Philadelphia. The company controls street railway and electric light and power properties in Portland. Proceeds from the note sale will be used to acquire the Mt. Hood Railway & Power Company of Portland. The notes which are callable on 60 days' notice after November 1, 1912, are secured by the deposit of the entire issue of first mortgage 5 per cent 30-year bonds and all the capital stock, $5,000,000 authorized and $1,000,000 issued, of the Mt. Hood Railway & Power Company. The bonds are convertible into stock of the company at par, at a price for the stock equal to the amount paid in on stock, plus $1 on each $100 share. Earnings of the company for fiscal year compare as follows:

	1911	1910
Gross earnings	$6,336,703	$5,638,896
Operating expenses and taxes	3,069,897	2,724,378
Net earnings	3,266,806	2,914,518
Interest charges	1,510,280	1,398,029
Balance	1,756,526	1,516,489

WATERWORKS.

MONMOUTH, ORE.—Bids for the bonds to be issued for the new $20,000 water system have been opened and the bid of the Lumbermens National Bank of Portland accepted.

TWIN FALLS, IDAHO.—Arrangements are now under way for providing Burley with up-to-date water and sewer systems. The village board has had the matter under consideration for some time.

REDLANDS, CAL.—Recommending a bond election for $600,000 for a municipal water system, Engineer F. E. Trask of Los Angeles and City Engineer George S. Hinckley of Redlands have filed their report for a municipal system for Redlands with the water commission and the City Trustee. Three new reservoirs are proposed and the system provides for new pipe lines on all streets and 70 miles of pipe line.